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FIG. 1

PRIOR ART

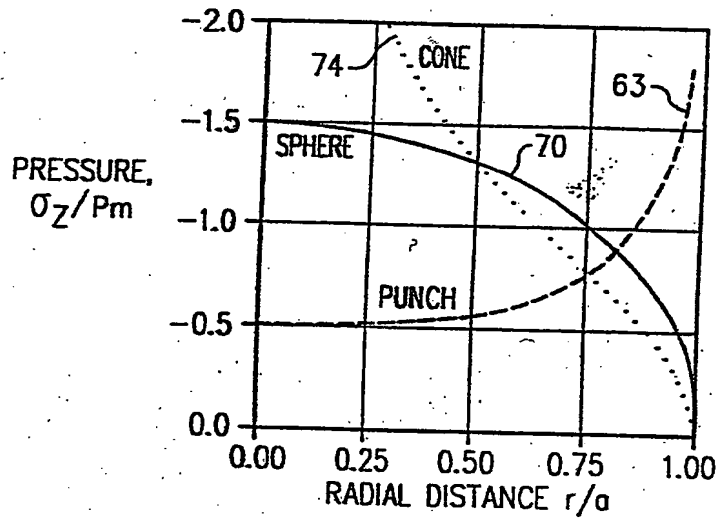


FIG. 2

PRIOR ART

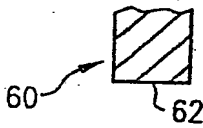


FIG. 3

PRIOR ART

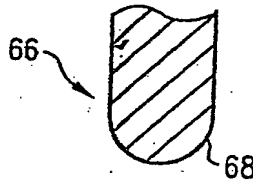


FIG. 4

PRIOR ART

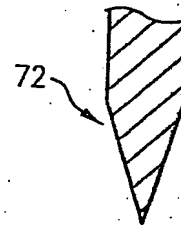
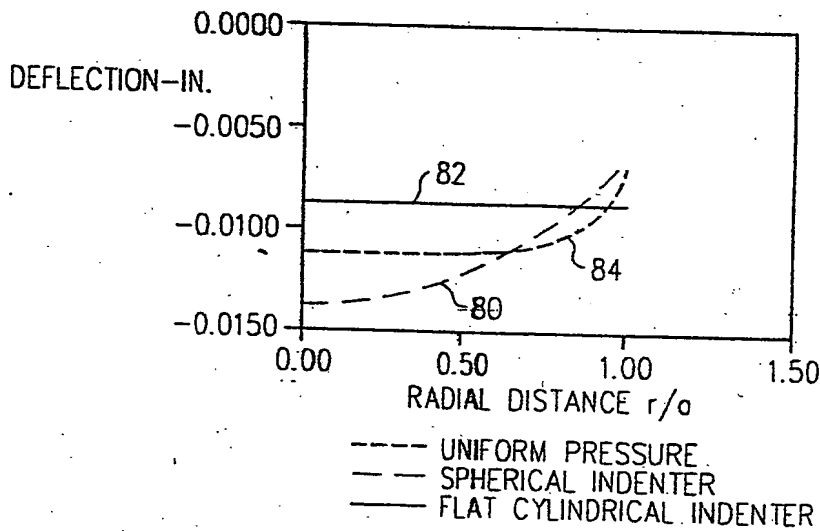


FIG. 5



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FIG. 6

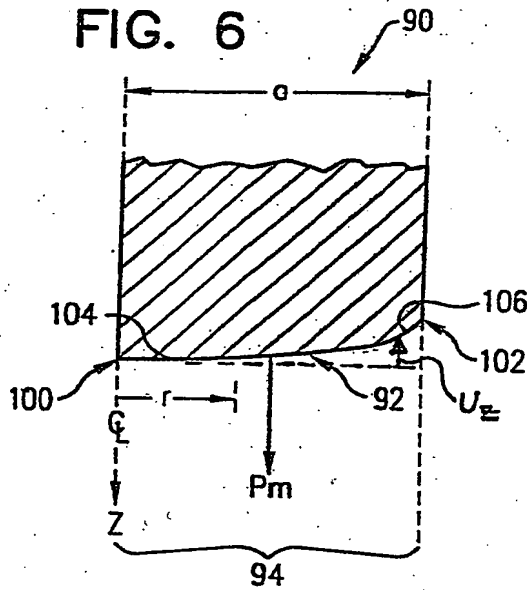


FIG. 7

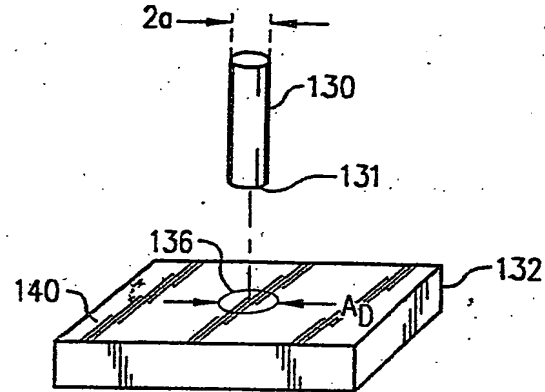


FIG. 8

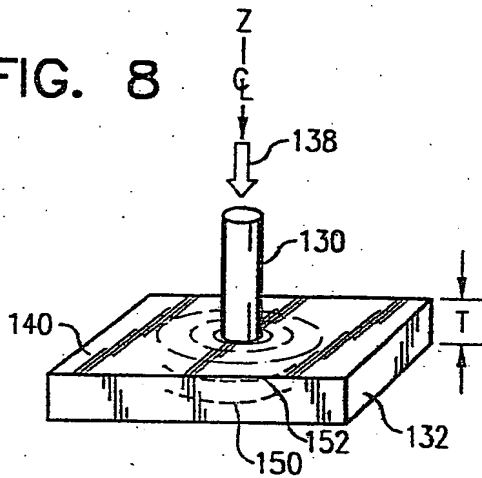


FIG. 9

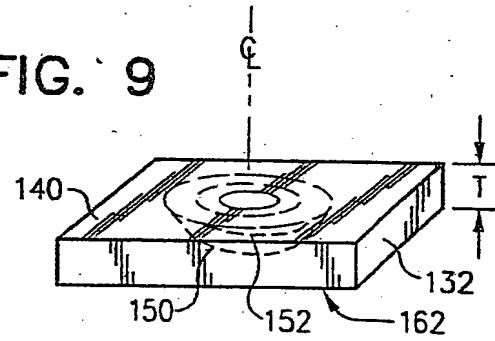
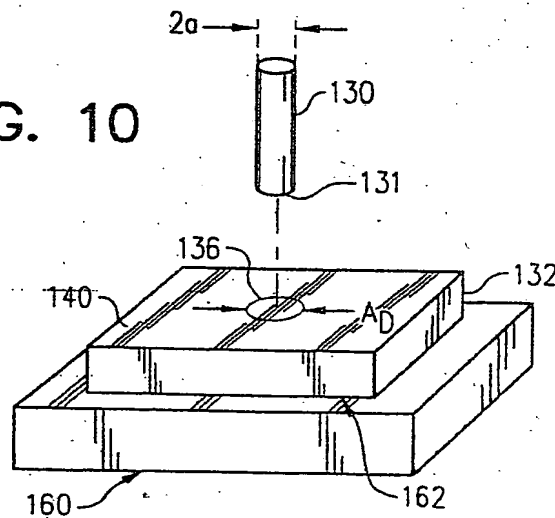


FIG. 10



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FIG. 11

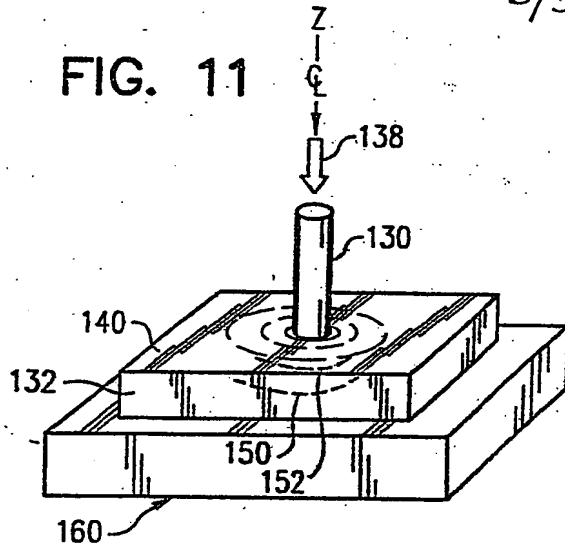


FIG. 12

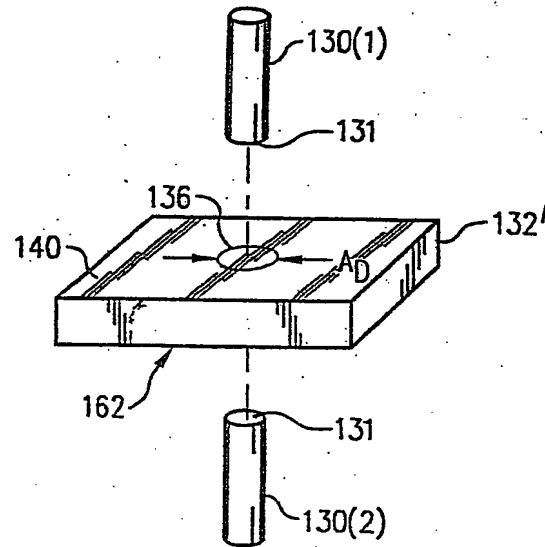


FIG. 13

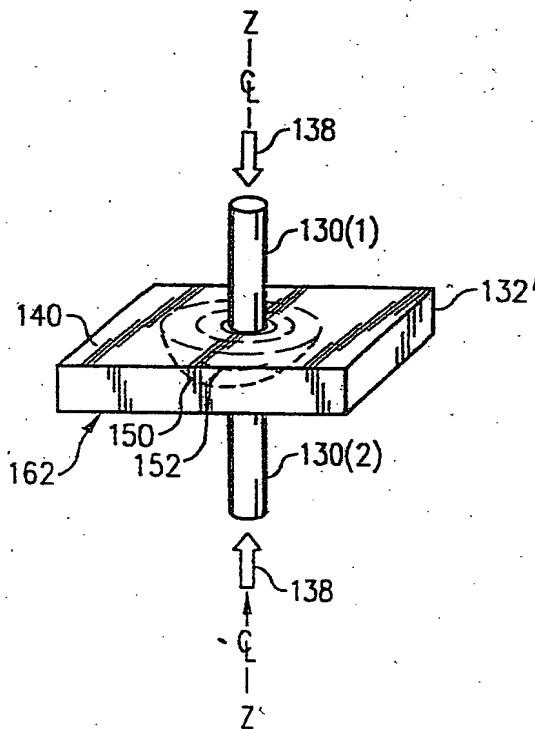
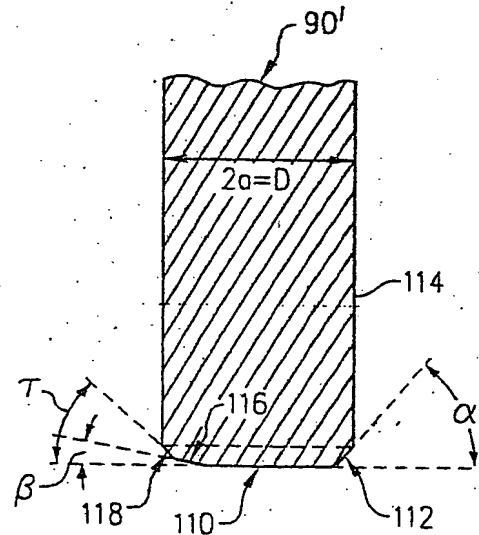


FIG. 14



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FIG. 15

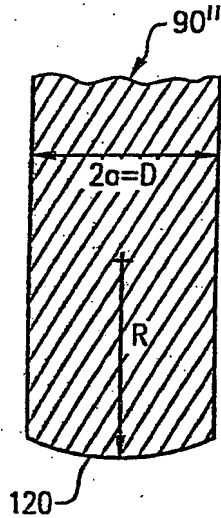


FIG. 16

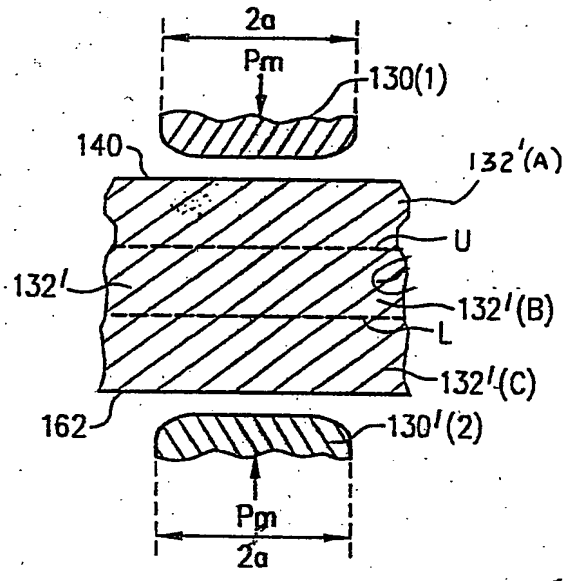


FIG. 17

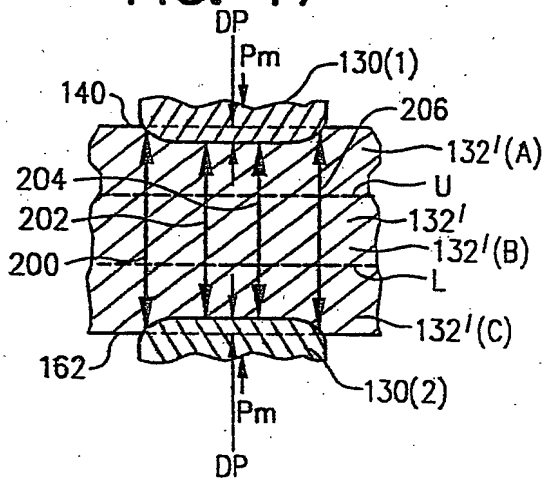


FIG. 18

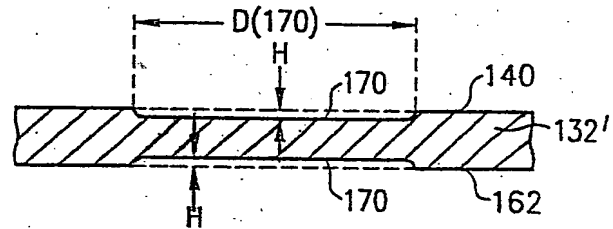


FIG. 19

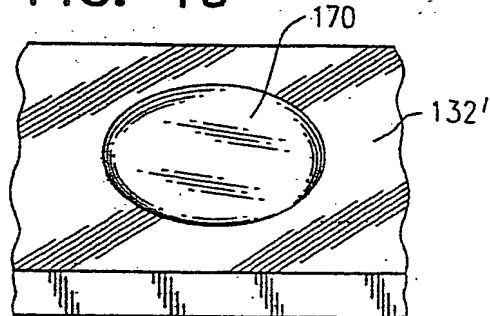
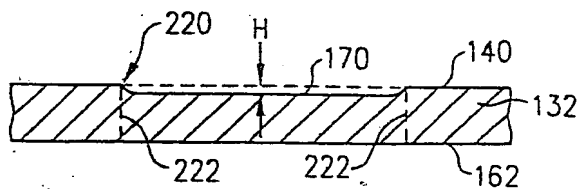


FIG. 20



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FIG. 21

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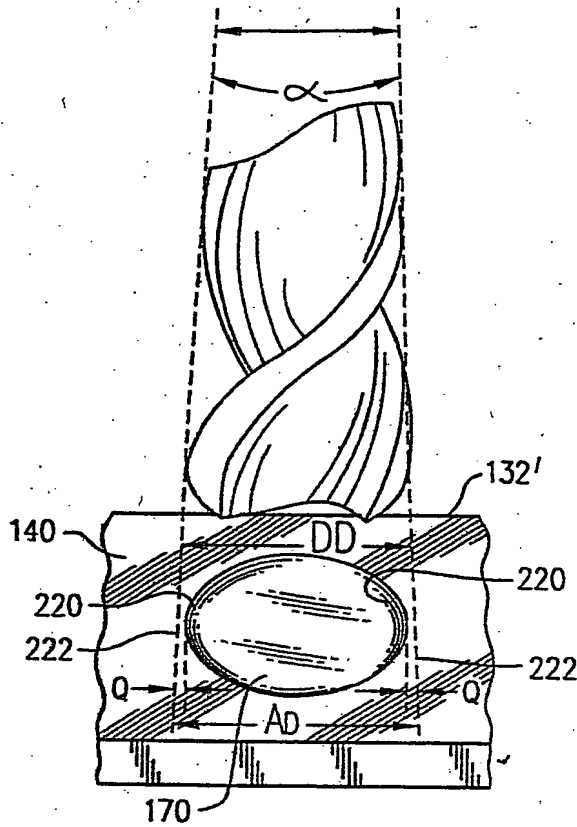


FIG. 22

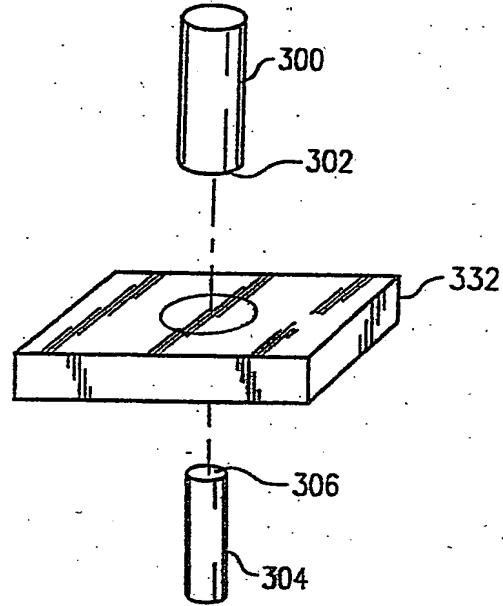


FIG. 24

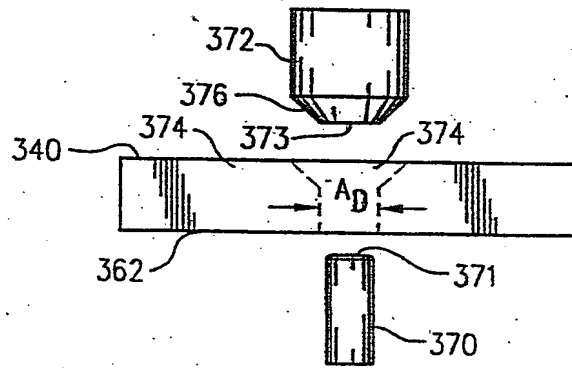


FIG. 23

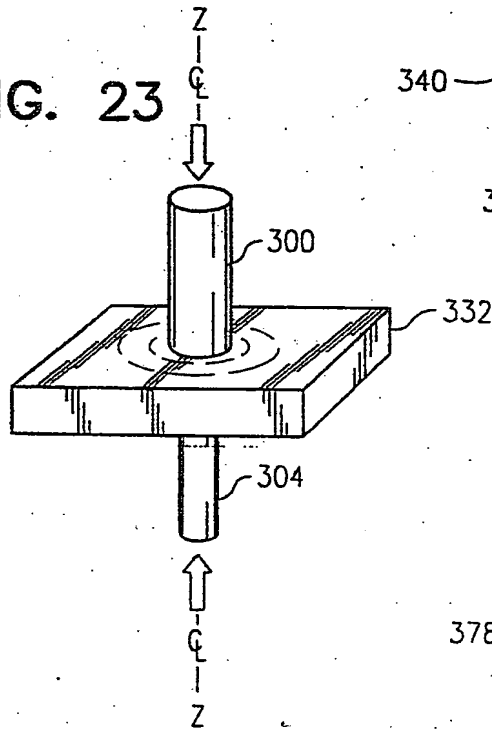
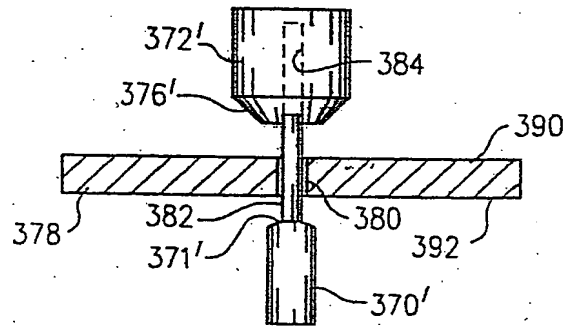


FIG. 25



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FIG. 26

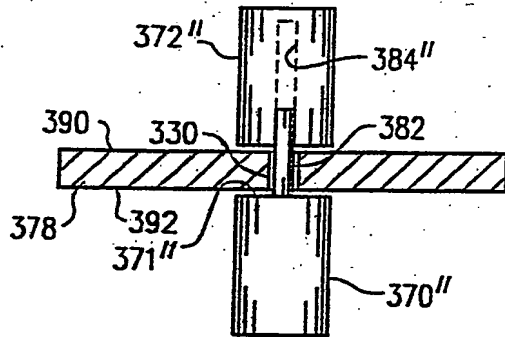


FIG. 27

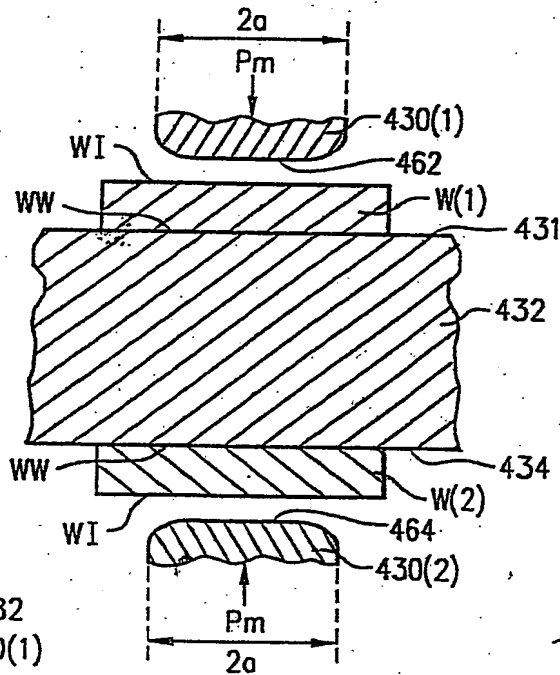


FIG. 28

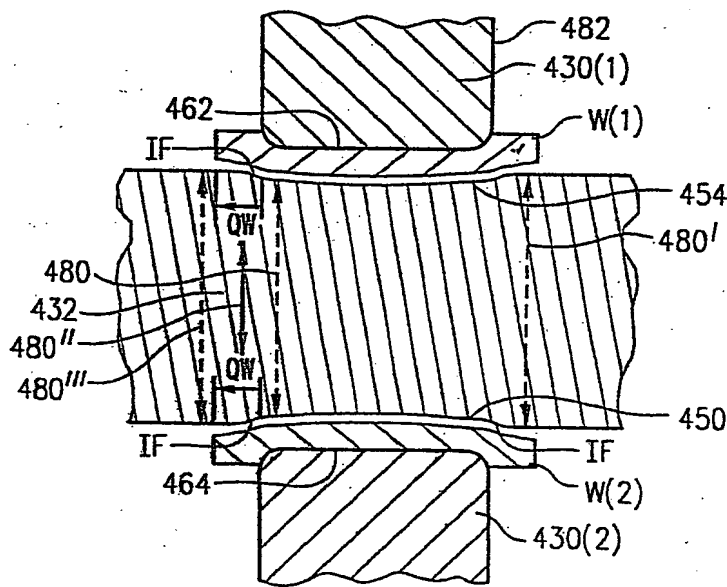


FIG. 31

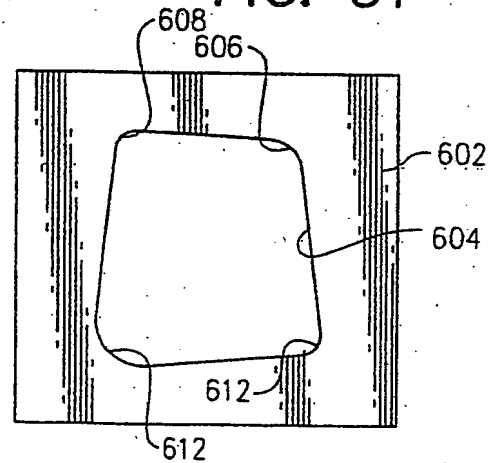
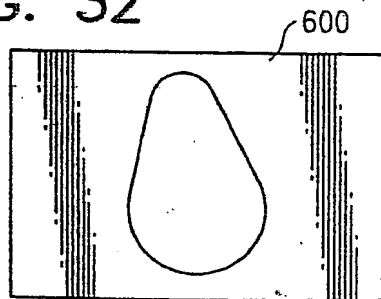


FIG. 32



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FIG. 29

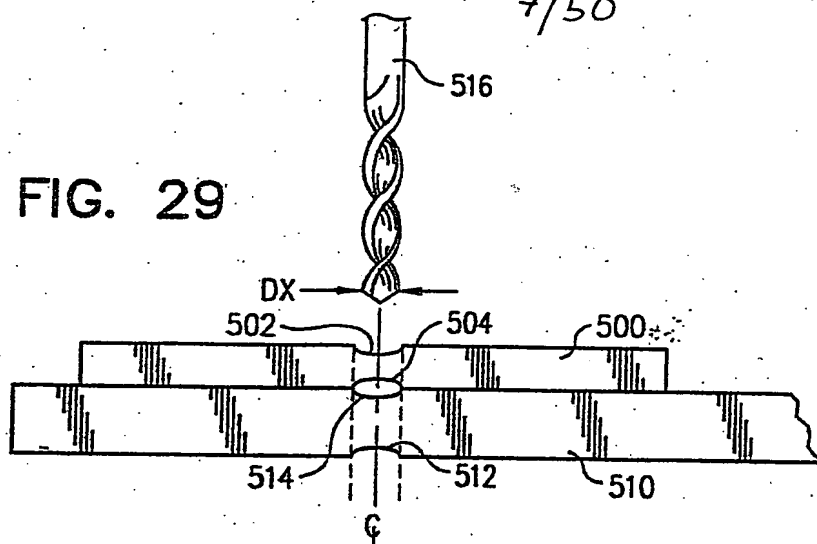


FIG. 33

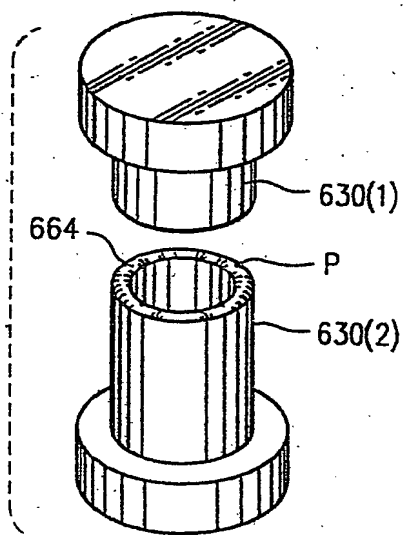


FIG. 30

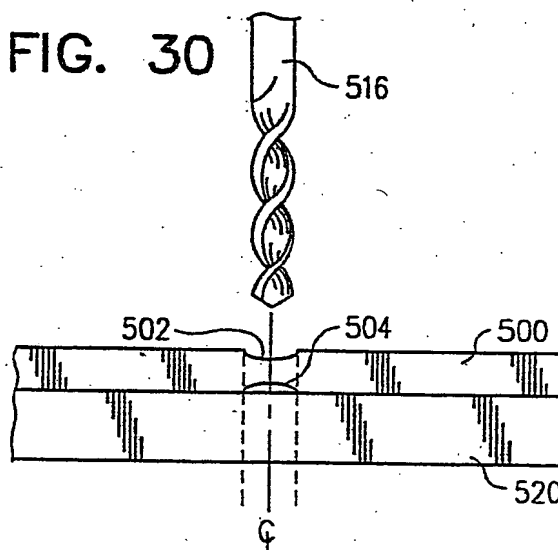
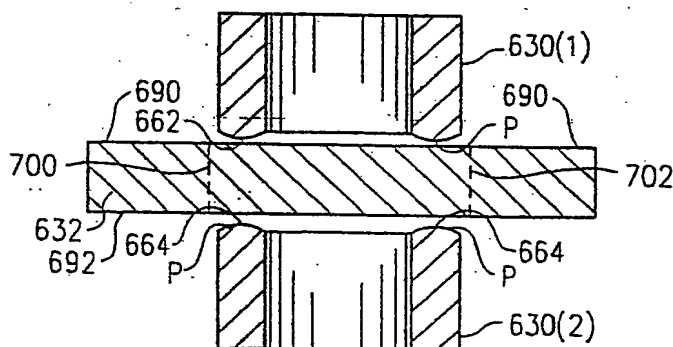


FIG. 34



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FIG. 35

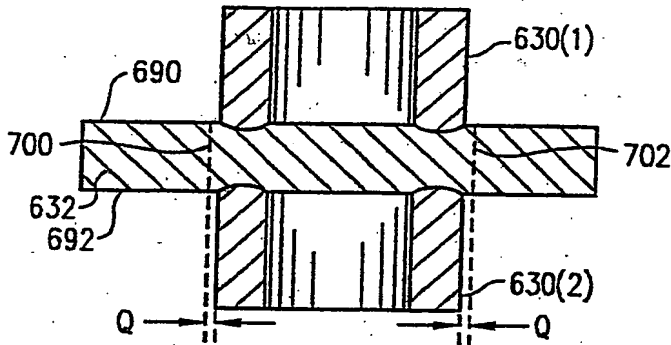


FIG. 36

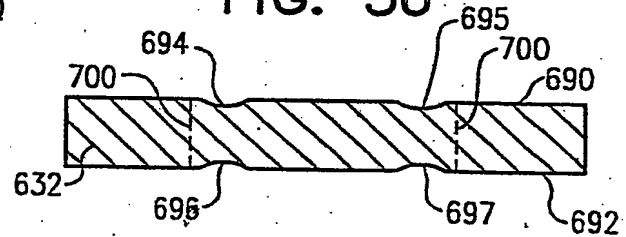


FIG. 37

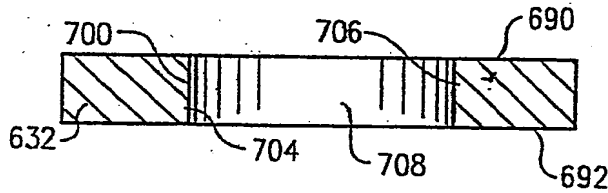


FIG. 48

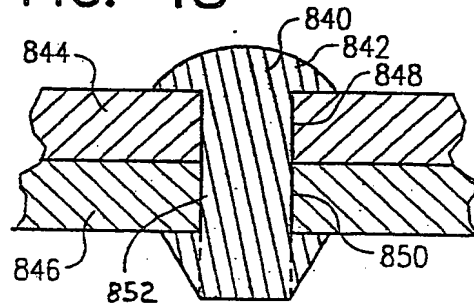
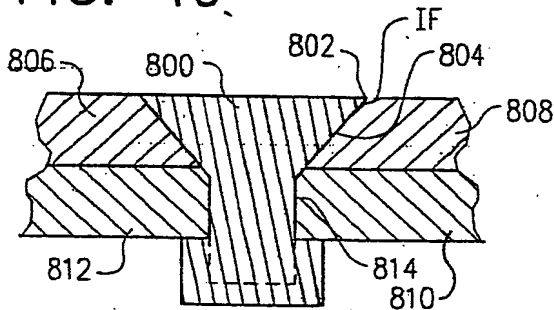


FIG. 49



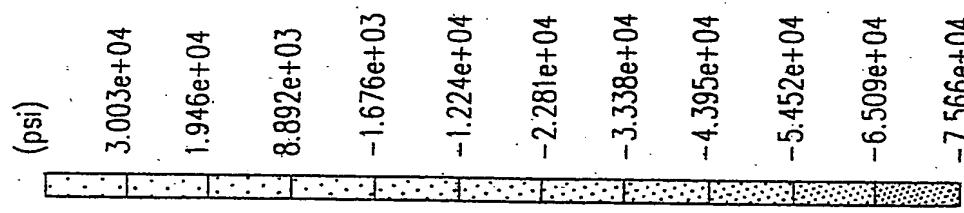
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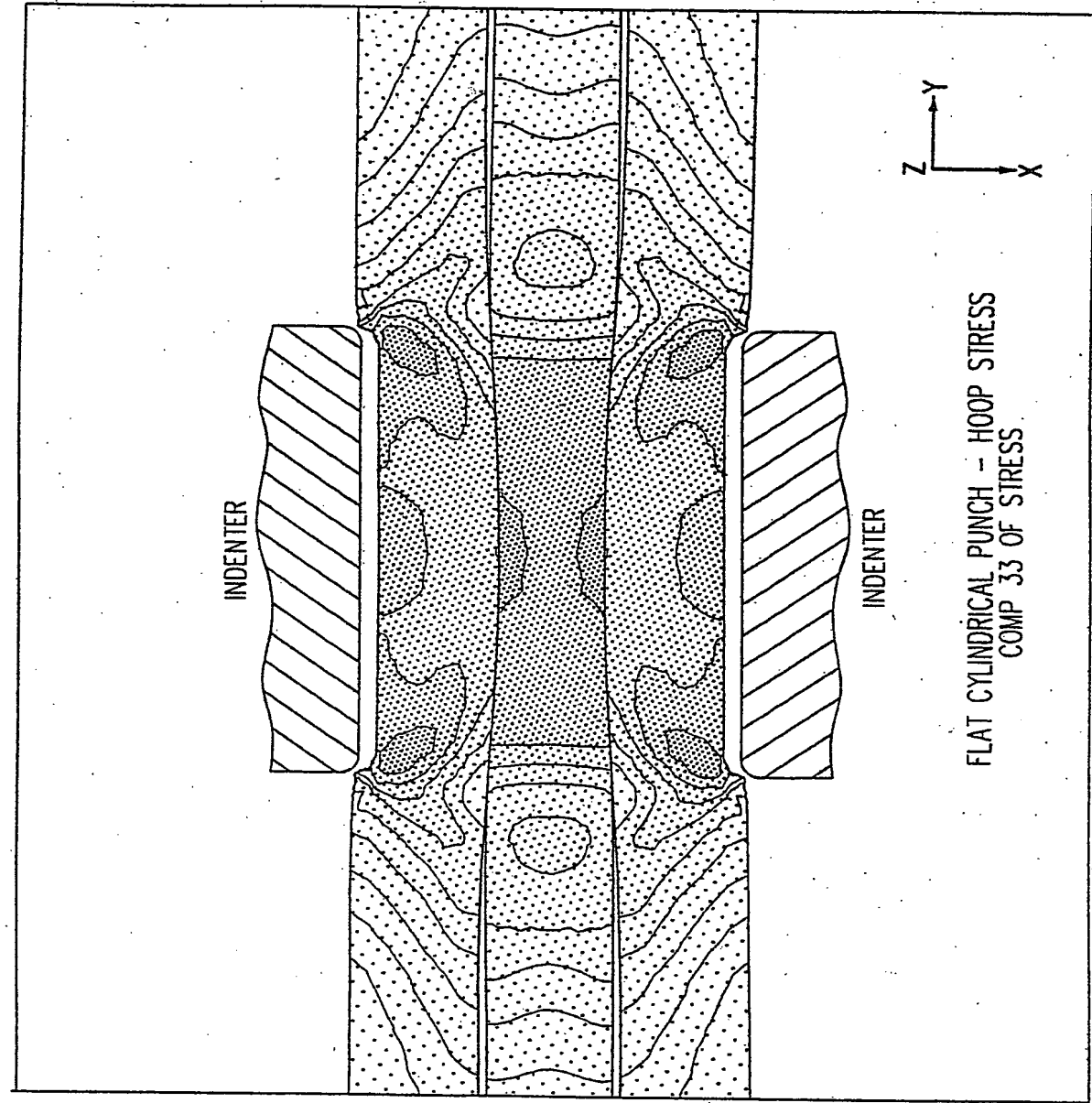
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FIG. 38

INC. 30
TIME: 2.000e+00



BEFORE DRILLING



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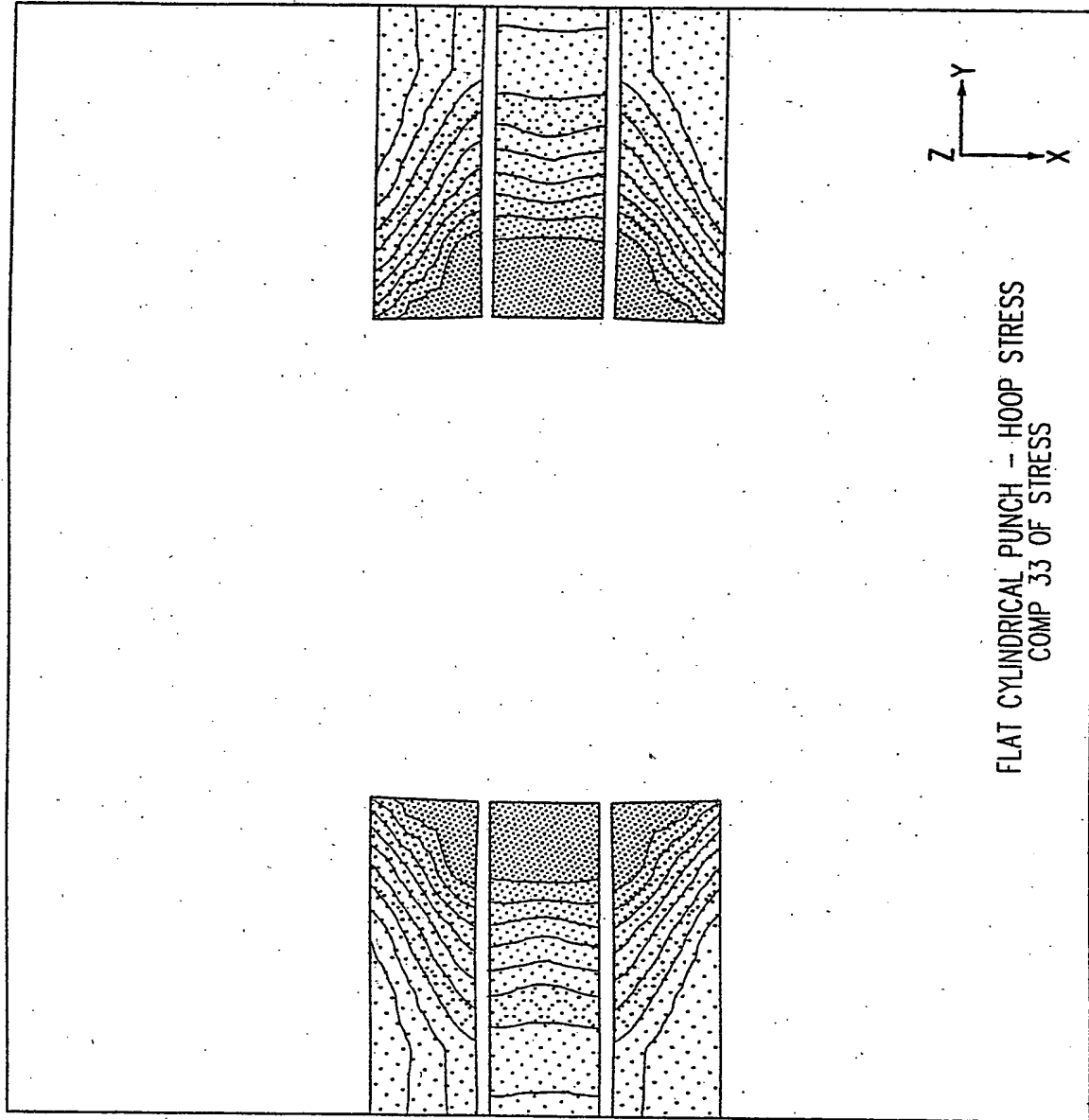
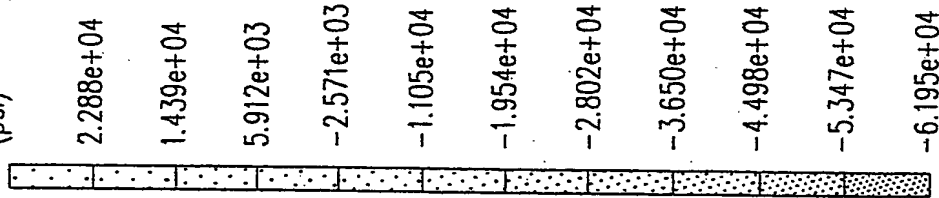


FIG. 39

INC: 40
 TIME: 4.000e+00

(psi)

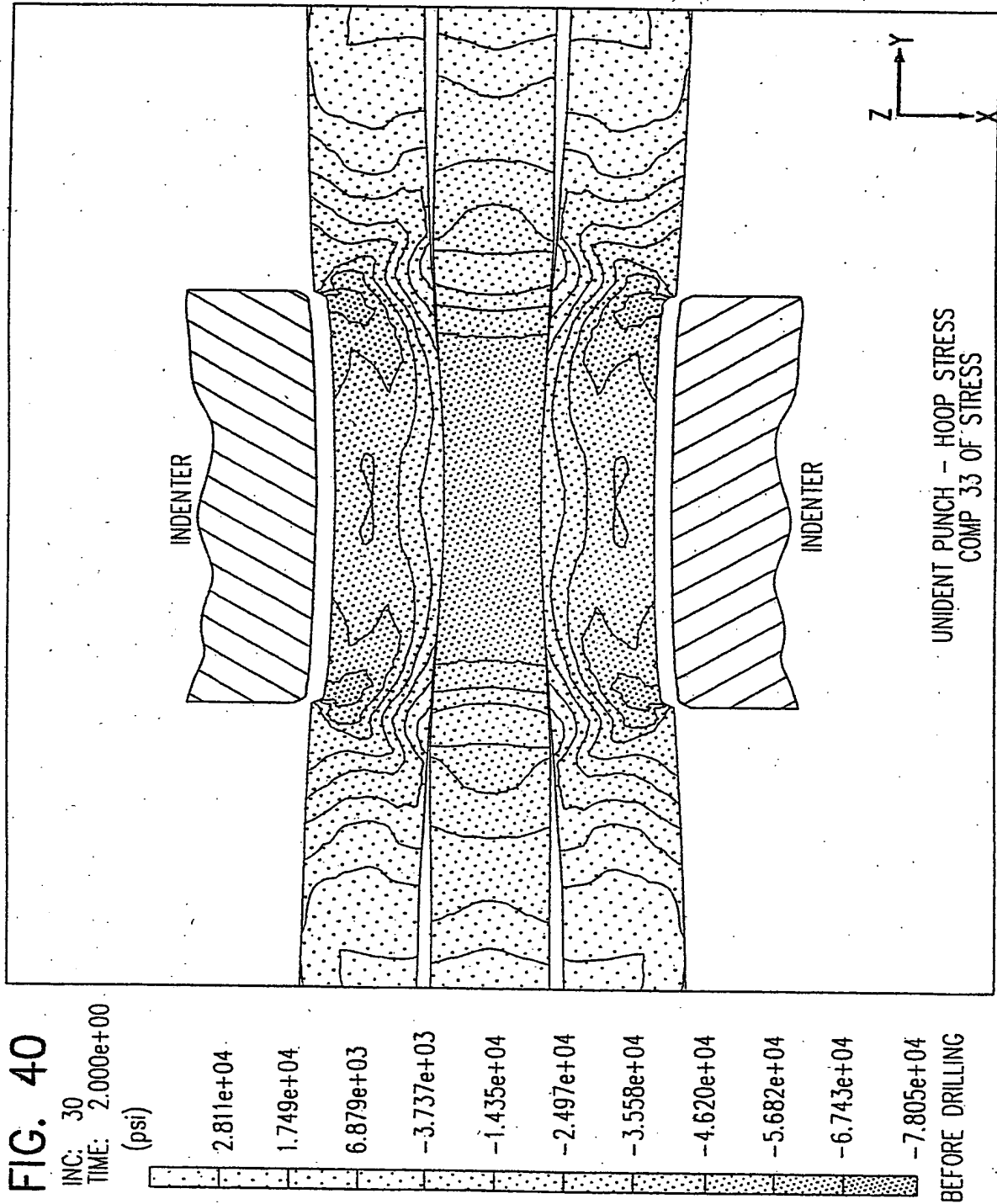


AFTER DRILLING

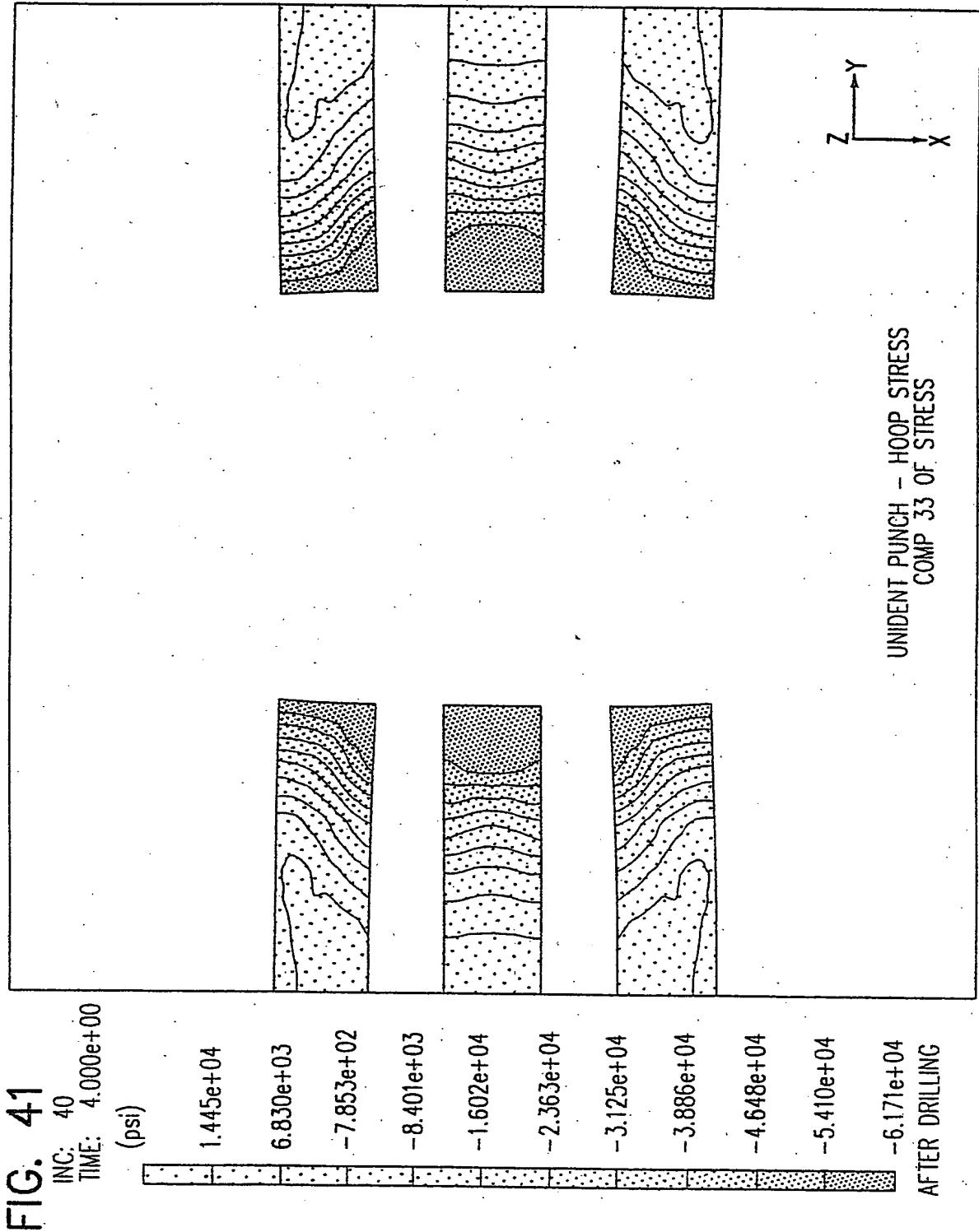
200EFO" 8049900F

200EFO" 8049900T

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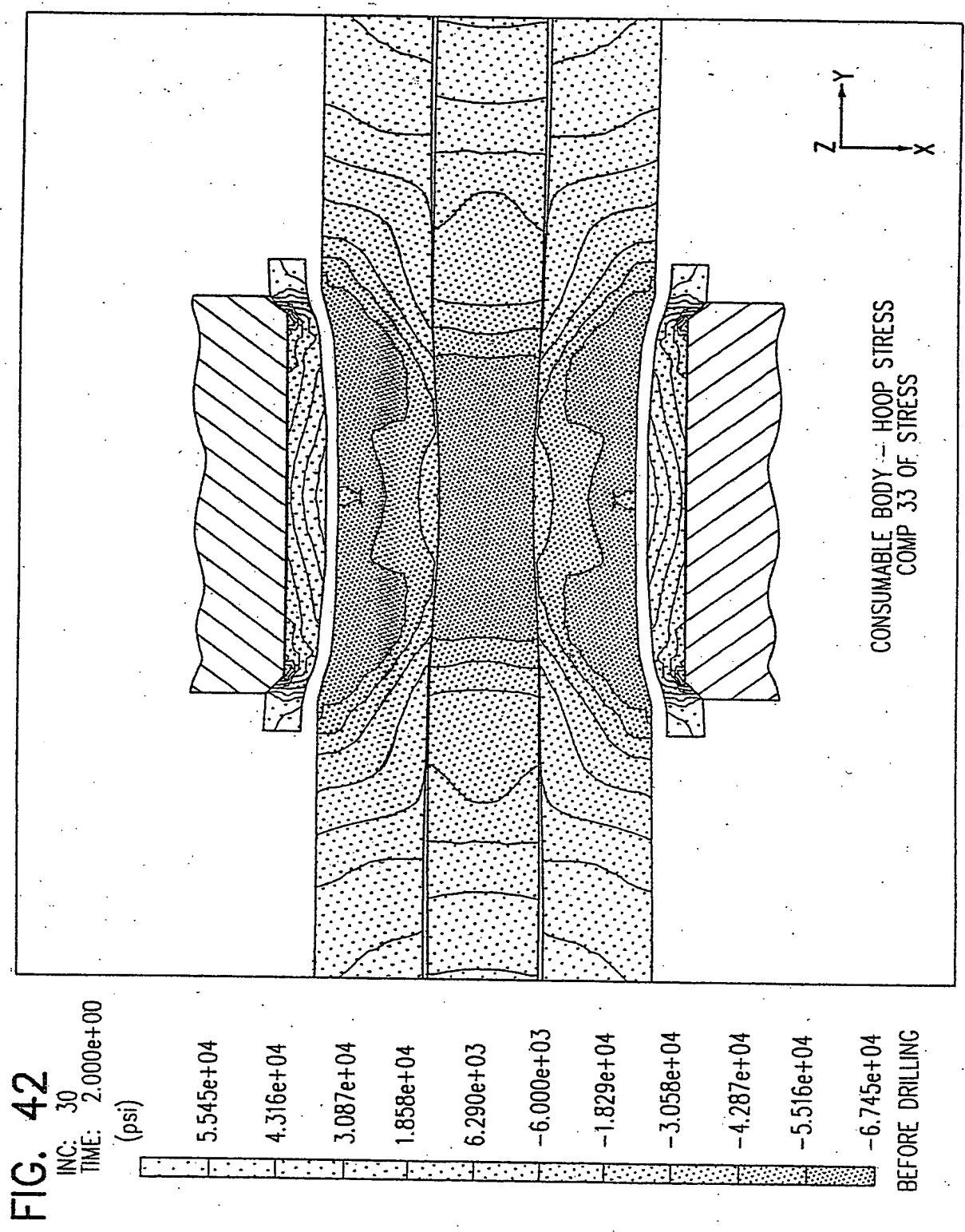
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200ETO" 8049900F

200ETO-8049900F

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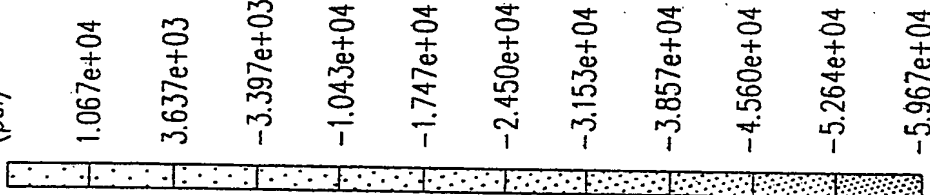


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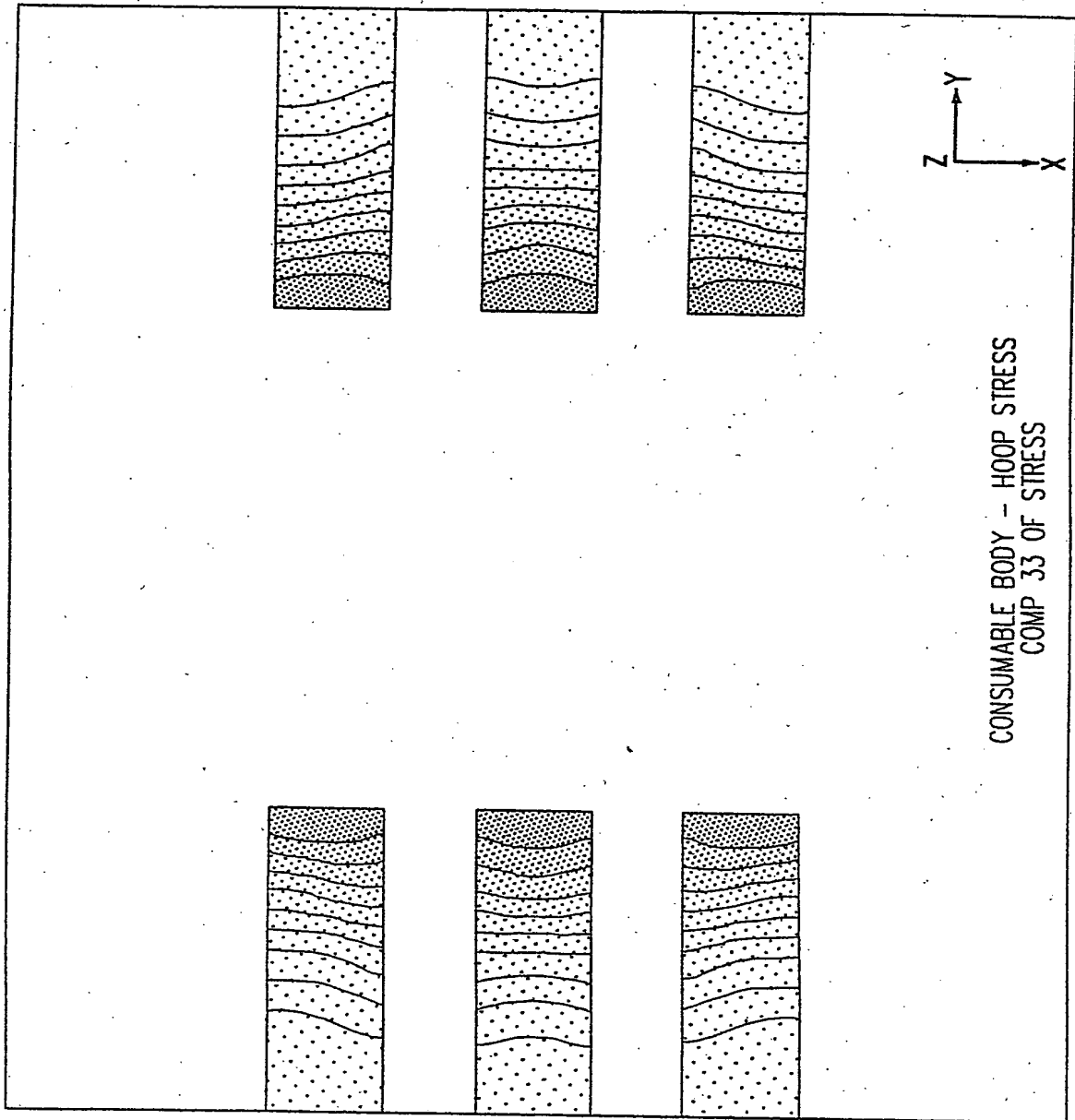
FIG. 43

INC: 40
 TIME: 4.000e+00

(psi)



AFTER DRILLING

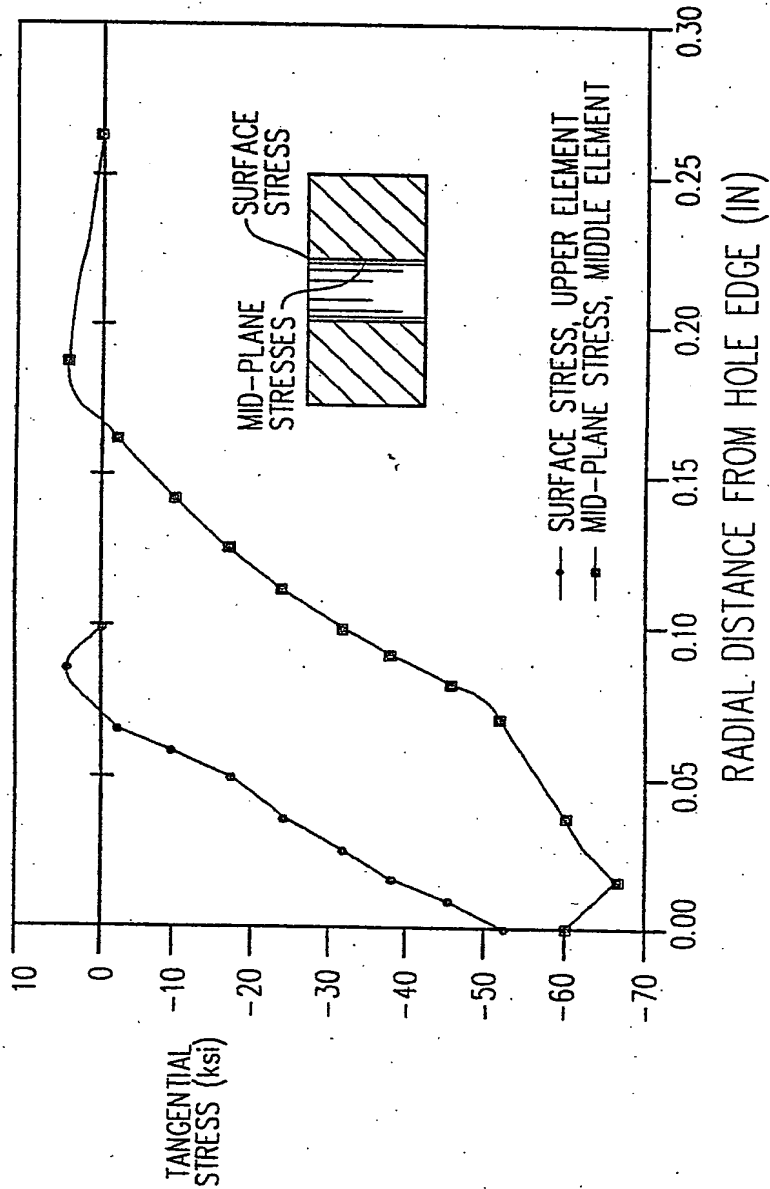


200EFO-8049900F

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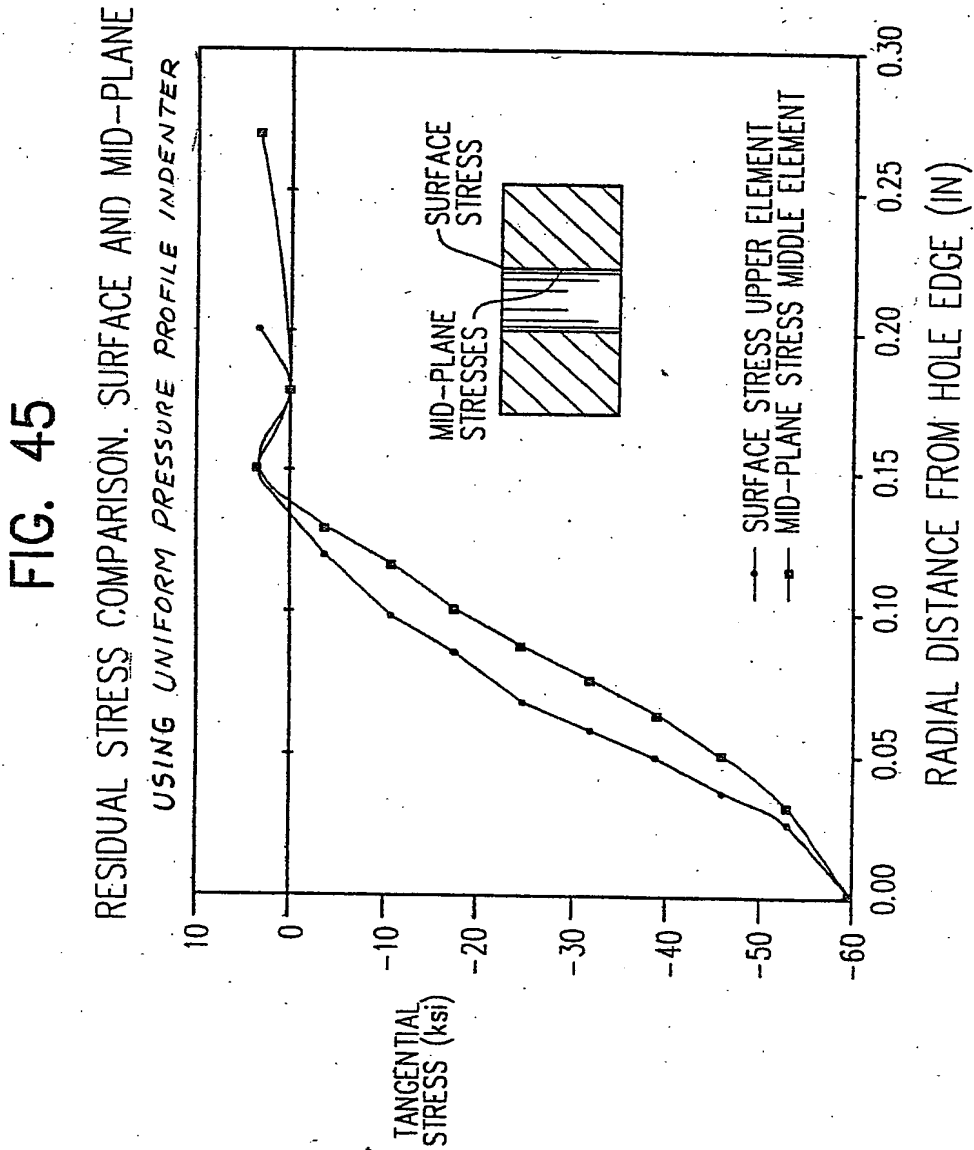
FIG. 44
 PRIOR ART

RESIDUAL STRESS COMPARISON, SURFACE AND MID-PLANE
 FLAT BOTTOMED CYLINDRICAL MANDREL



20040701 80499001

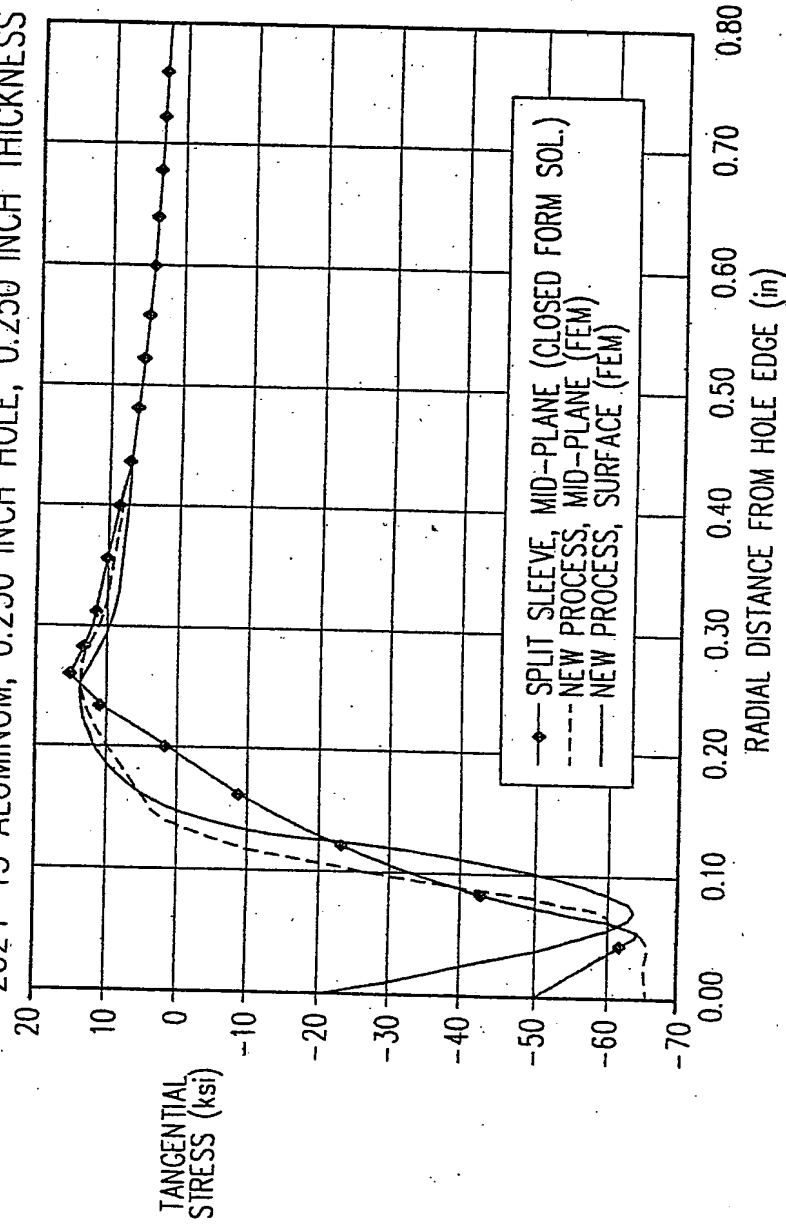
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FIG. 46

RESIDUAL STRESSES COMPARISON, NEW PROCESS vs SPLIT SLEEVE,
2024-T3 ALUMINUM, 0.250 INCH HOLE, 0.250 INCH THICKNESS

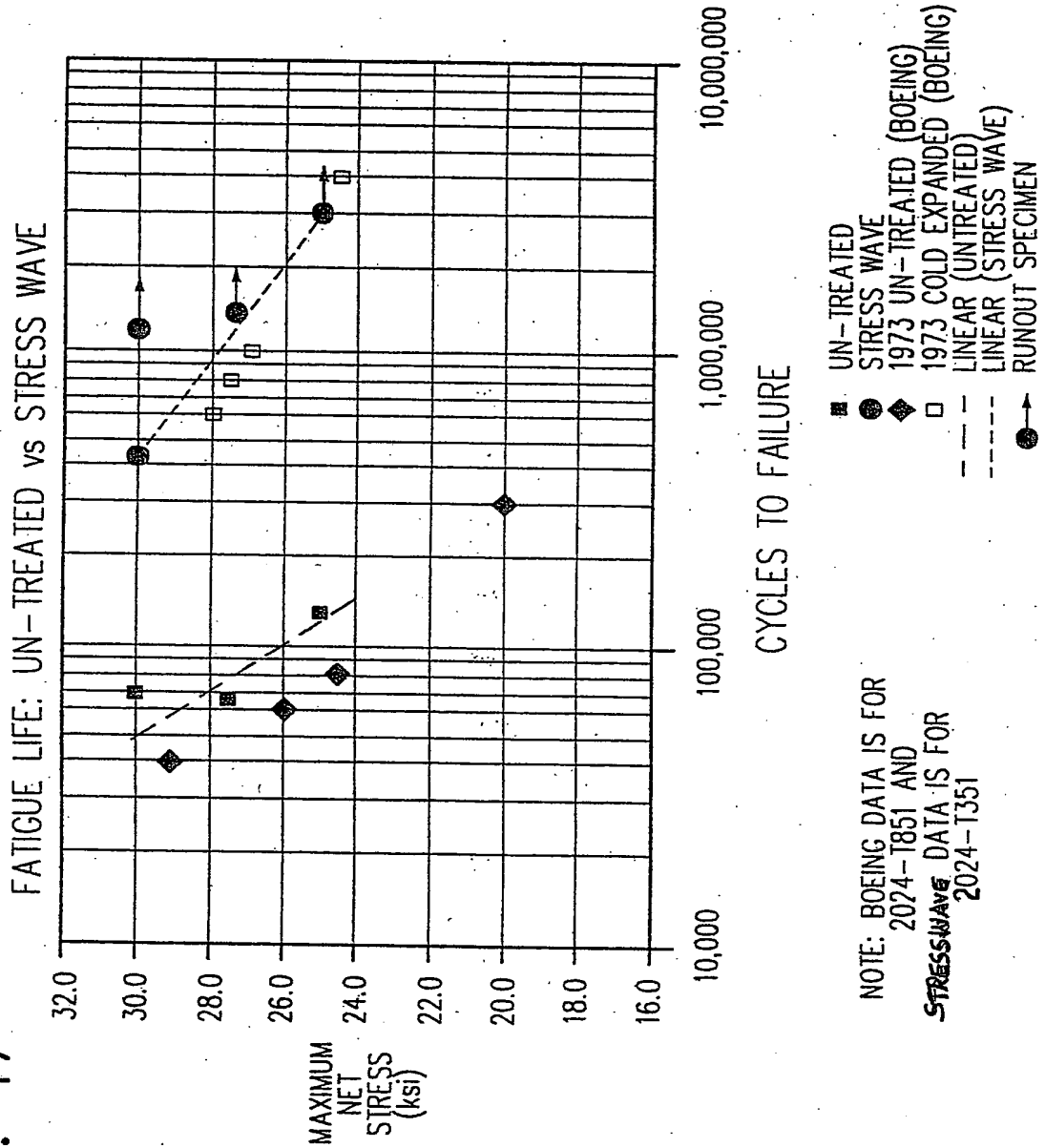


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FIG. 47



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FIG. 50

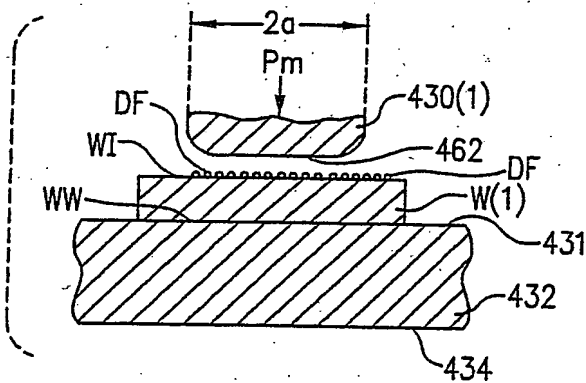


FIG. 52

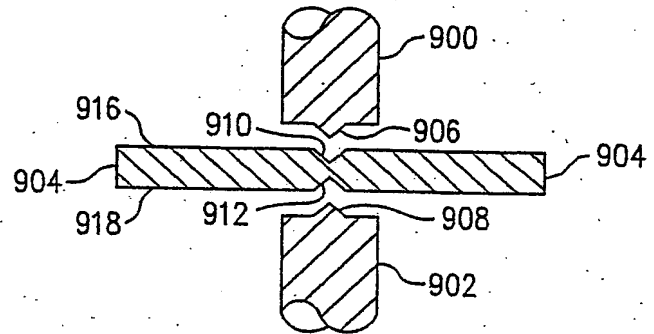


FIG. 53

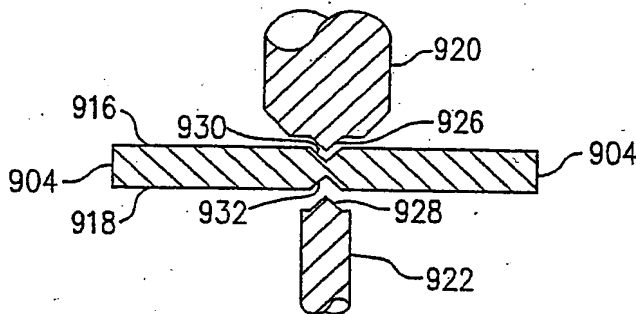
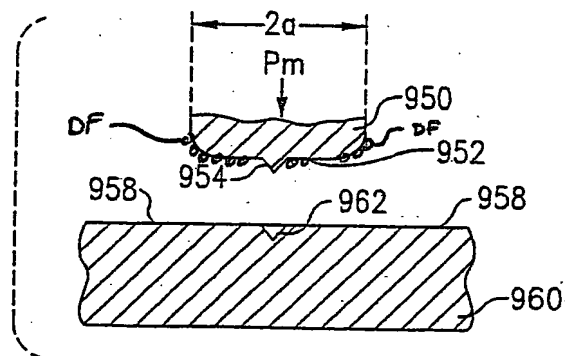


FIG. 54



200E10-80499007

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FIG. 51

FIG. 51A

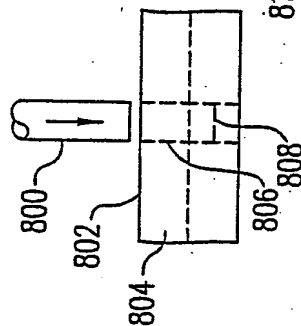


FIG. 51B

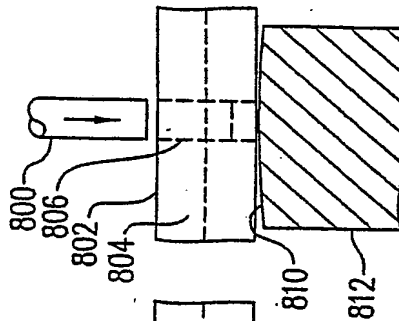


FIG. 51C

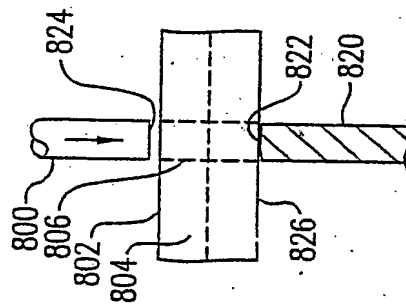


FIG. 51D

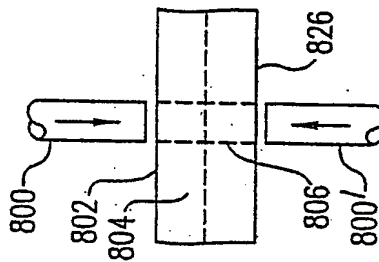
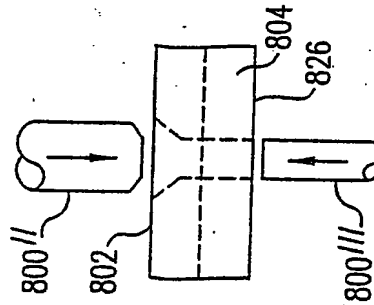


FIG. 51E



200EFO-8049300F

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FIG. 55

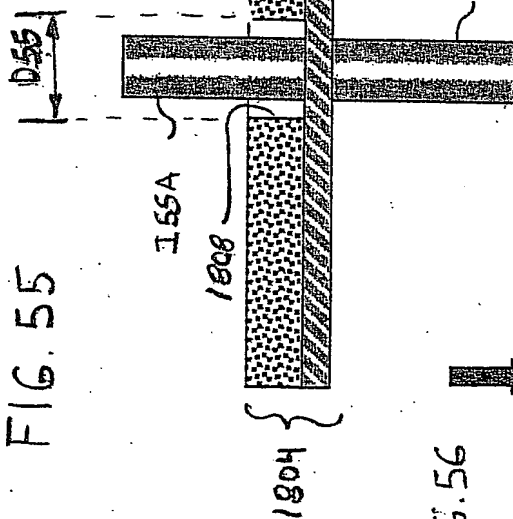


FIG. 57

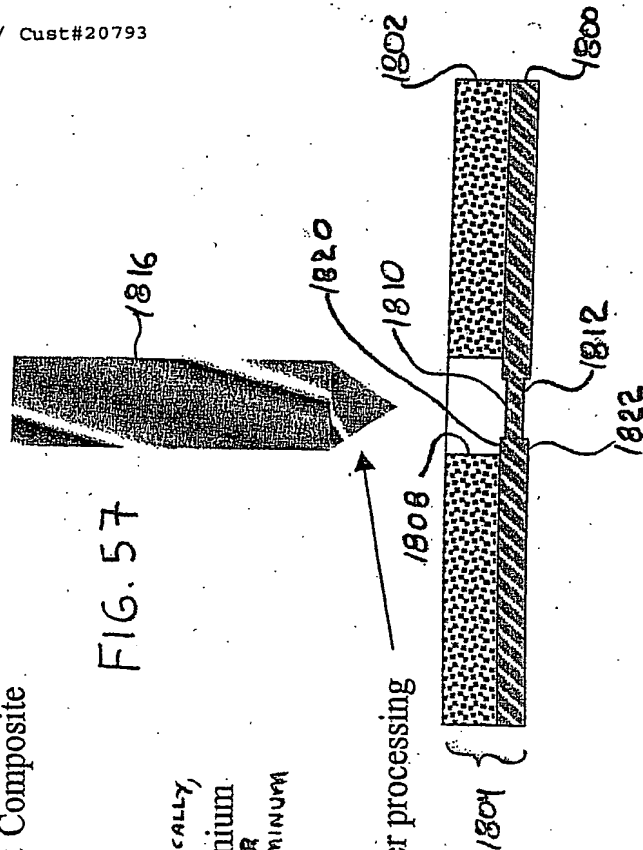
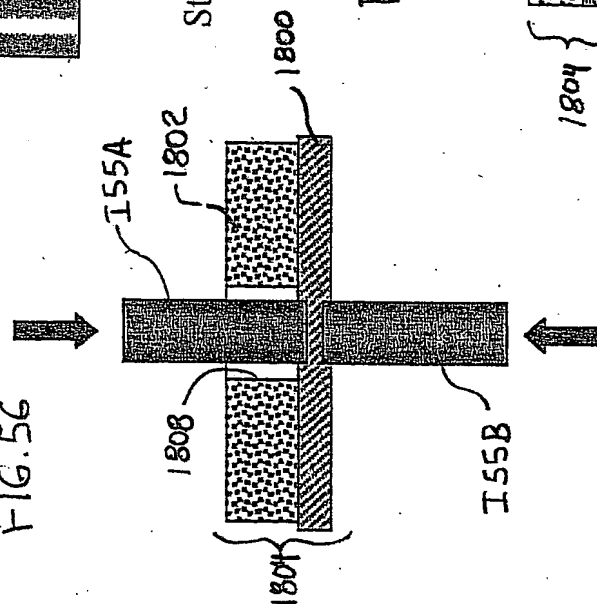
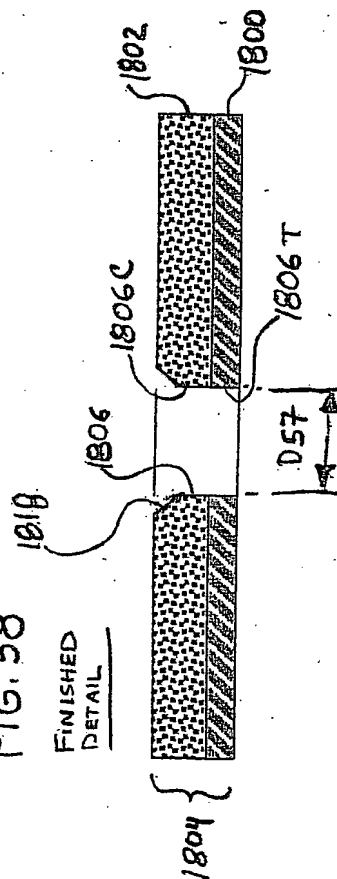


FIG. 56



Stack up is matched drilled after processing

FIG. 58

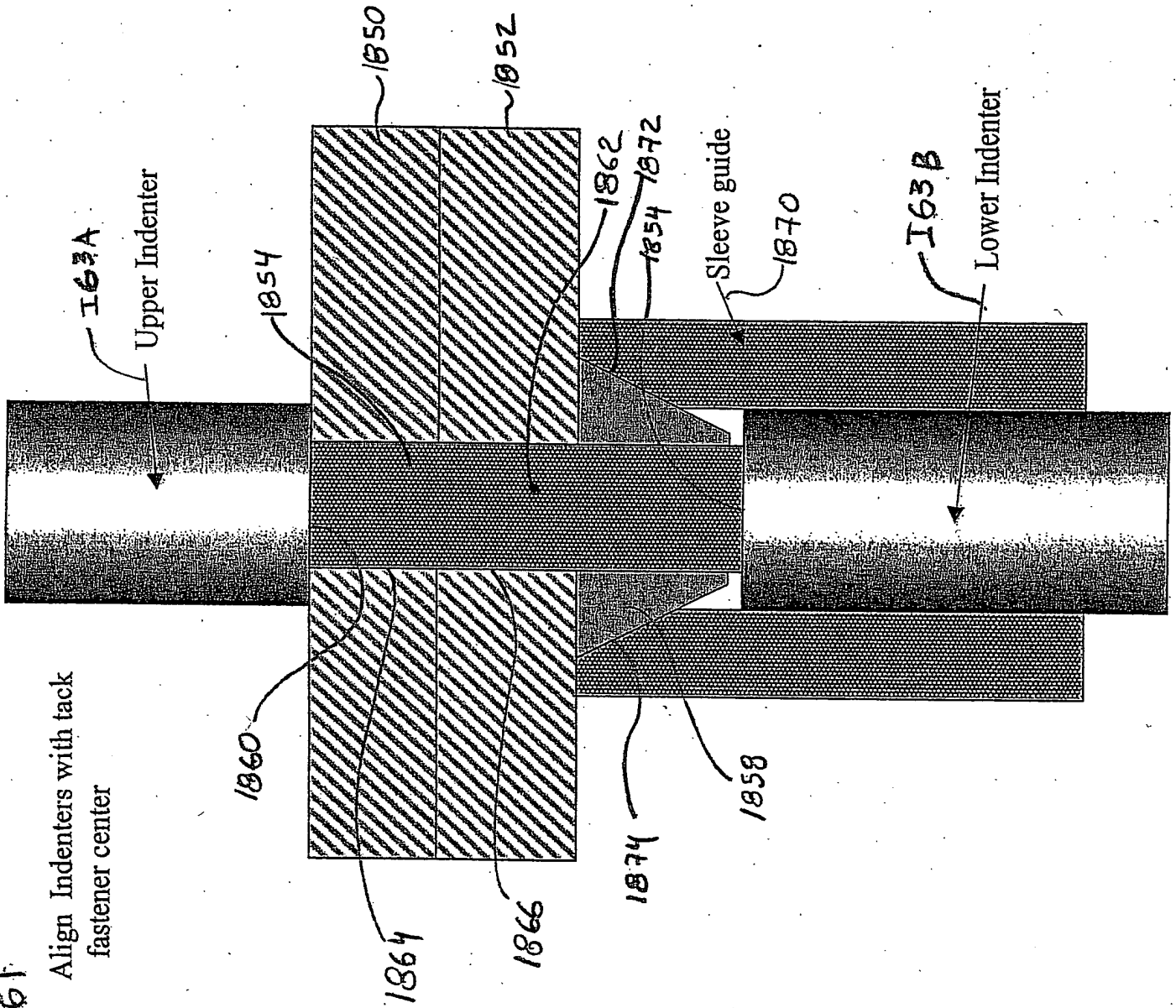


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FIG. 6f

Align Indenters with tack
fastener center



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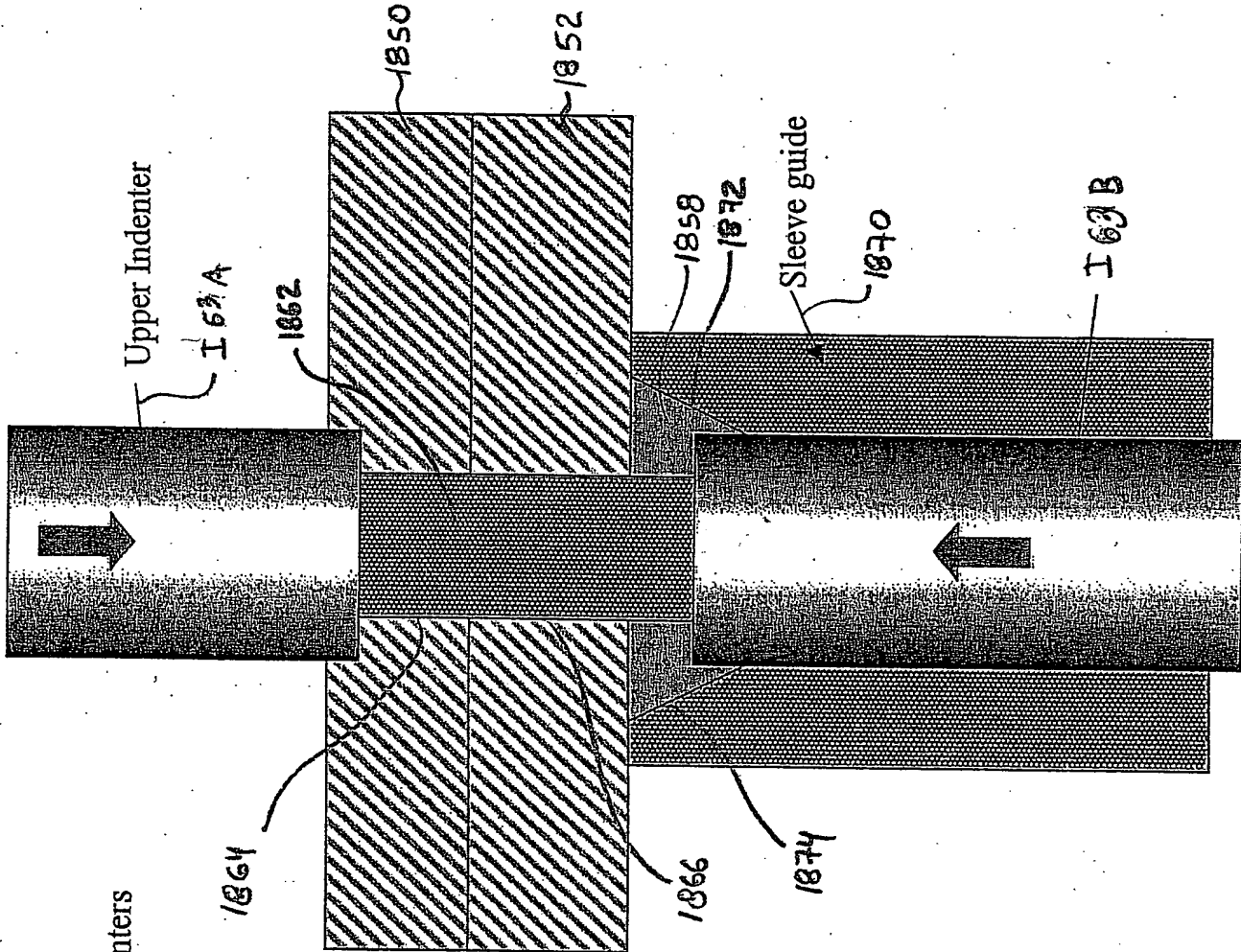


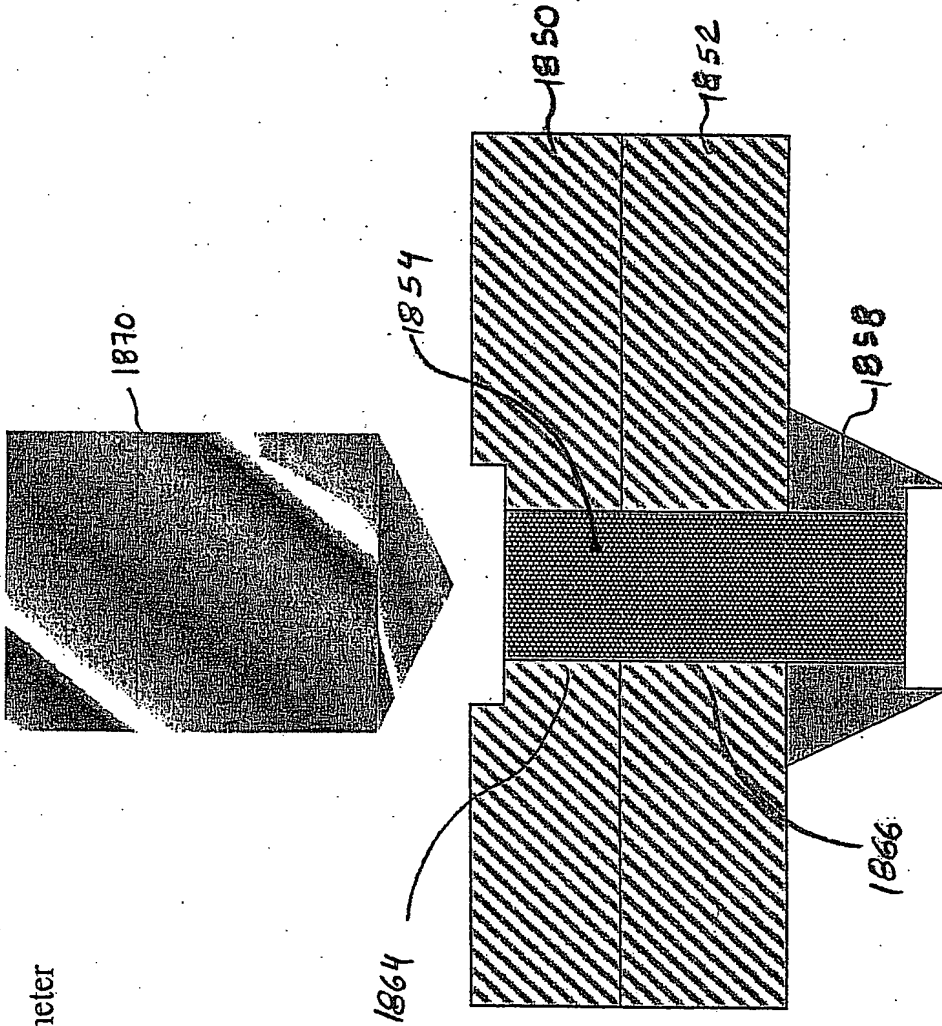
FIG. 62

Actuate Indenters

200610-8049500T

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FIG. 63



Drill to bolt diameter

200ETO-8049900T

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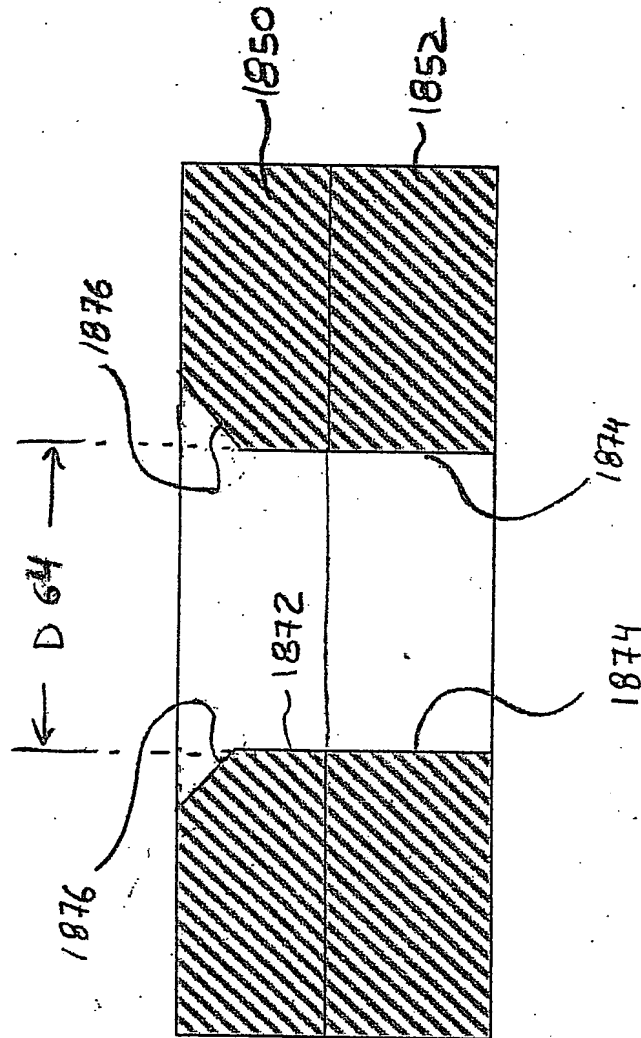


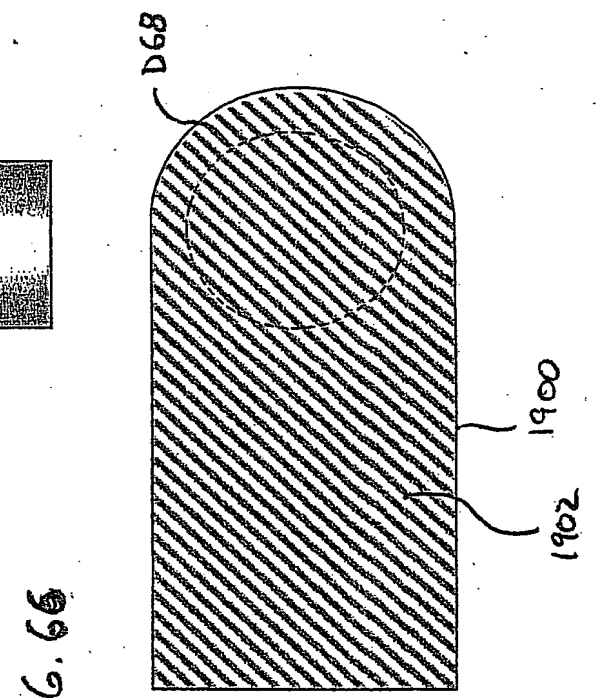
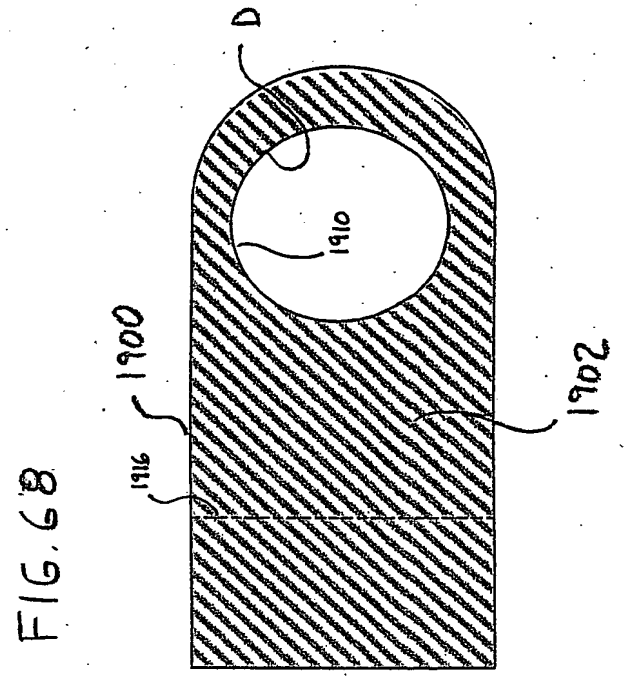
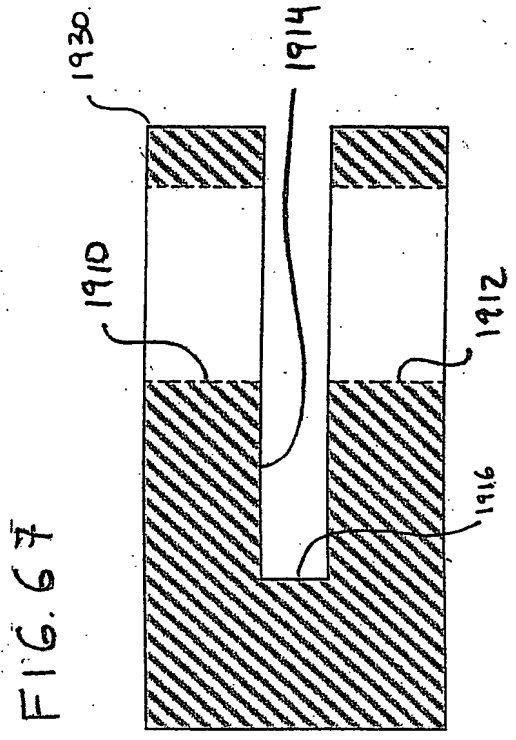
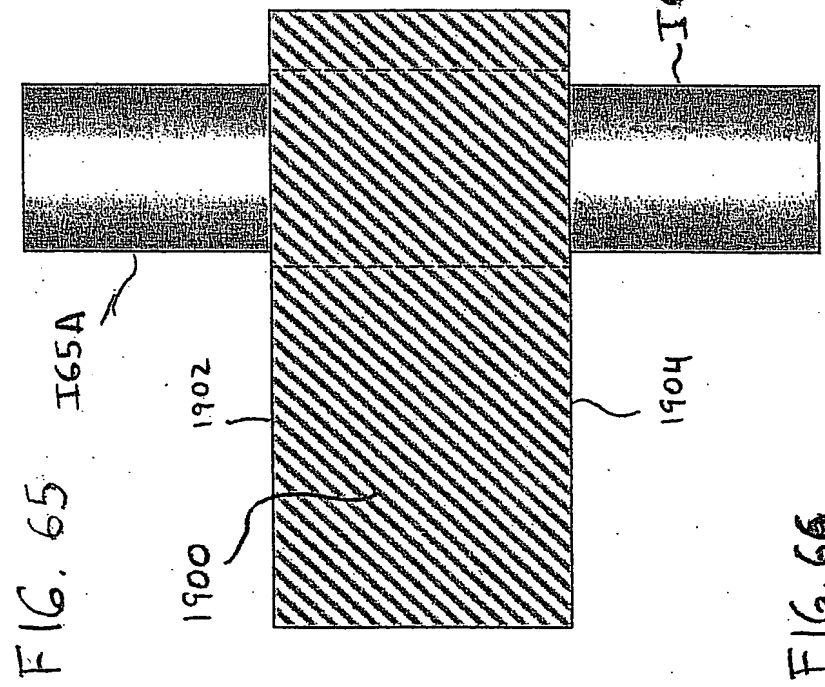
FIG. 64

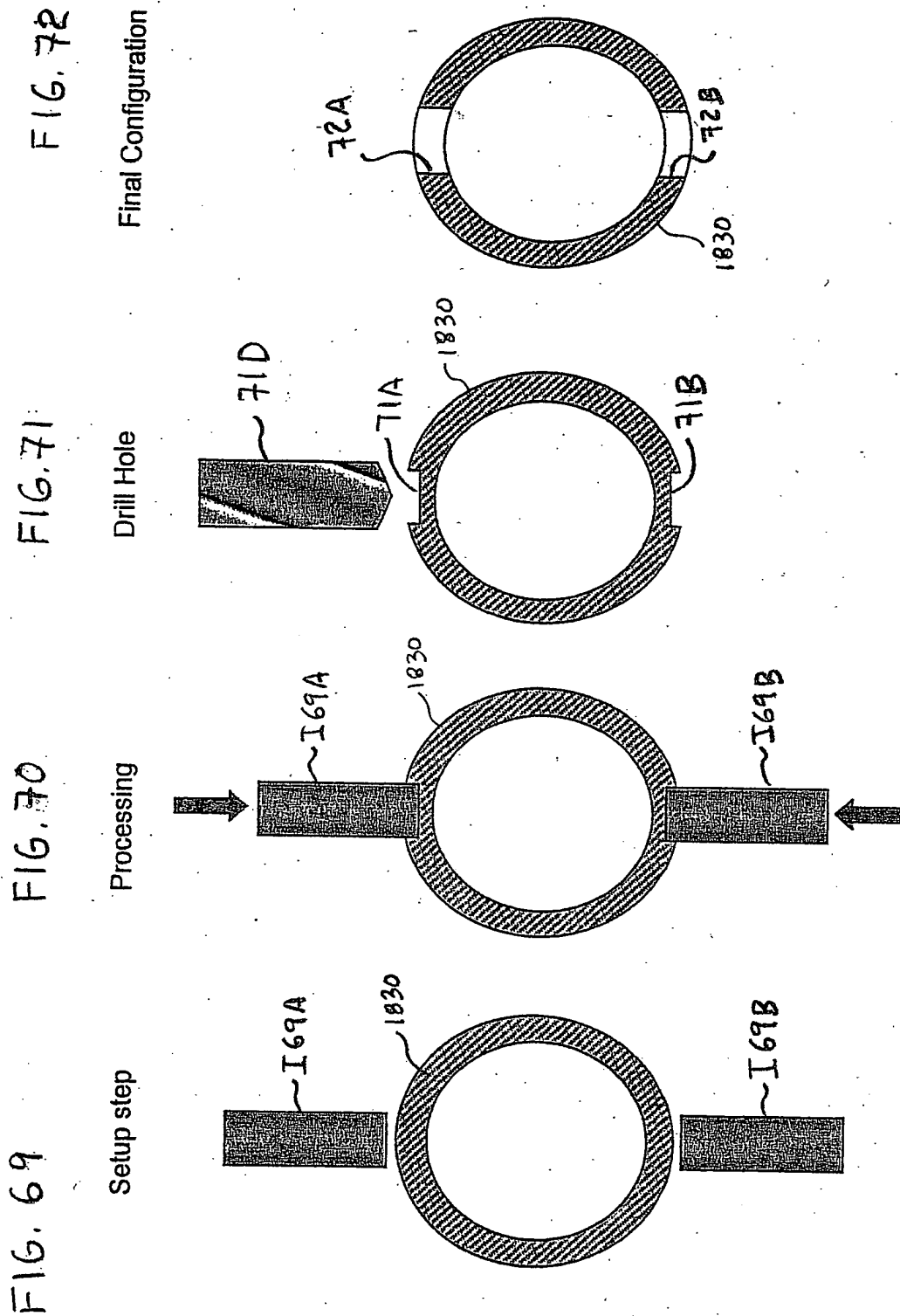
Finished treated hole

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200ETO" 8049900T

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Treatment of a tubular bar without internal support

Cross-Sectional view of processing step

[illegible]

Tapered mandrel with flat to support tube while processing. Mandrel is tapered on both ends to facilitate insertion and removal and to "reshape" cross-section after processing.

Treatment of a tubular bar with internal support

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Cross section of hollow tube treated with indenter end shape that conforms to tube diameter

FIG. 75

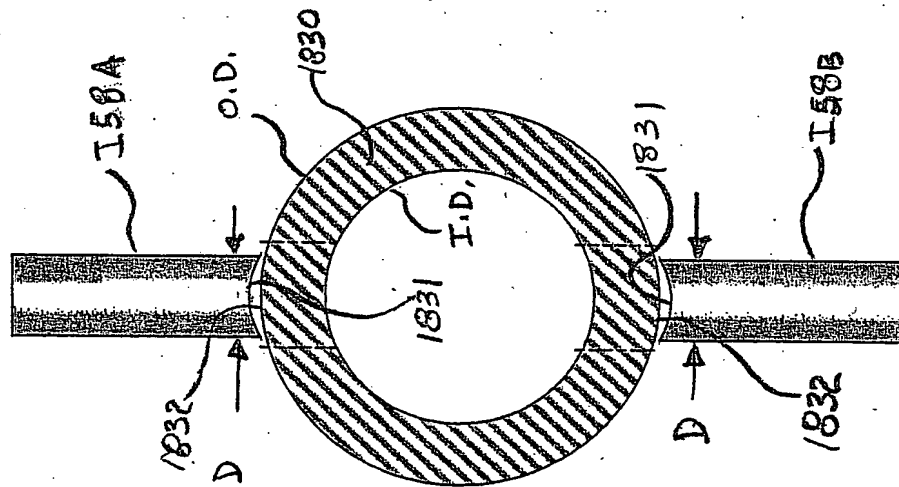


FIG. 76

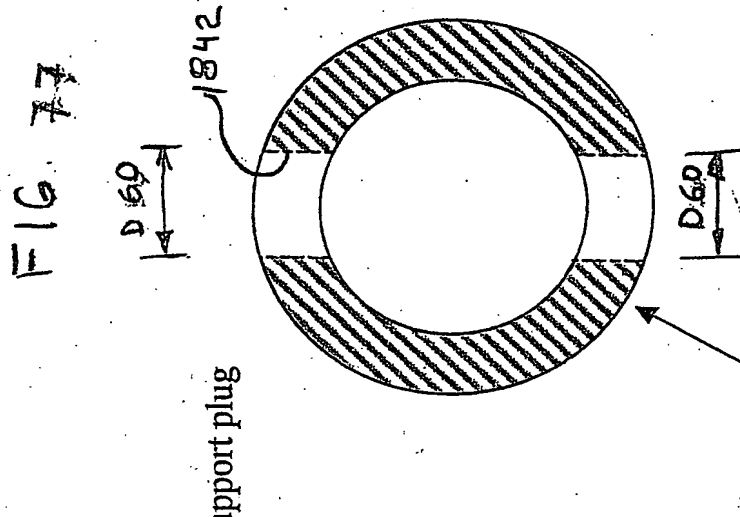
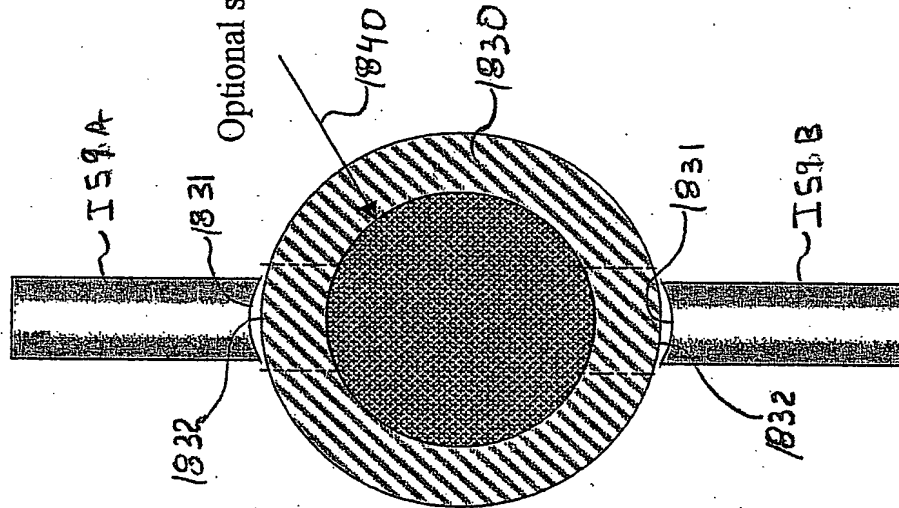


FIG. 77

2004EFO-8049900F

FIG. 78

Setup step

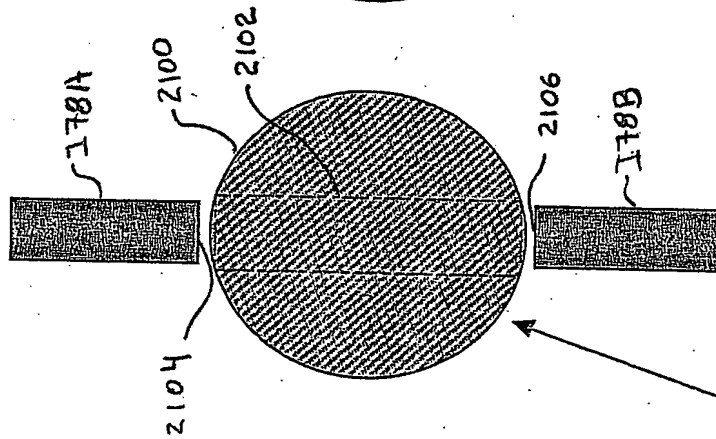


FIG. 79

Processing

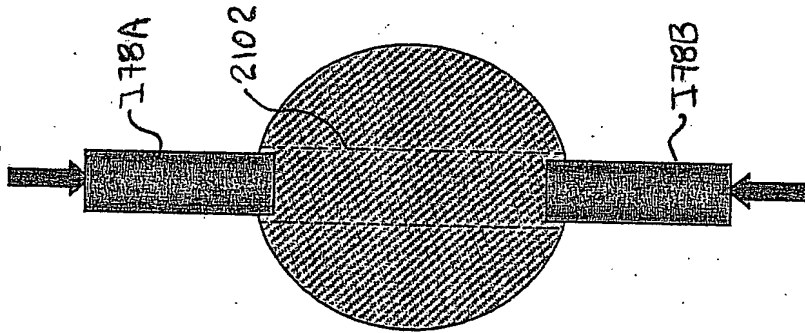


FIG. 80

Drill Hole

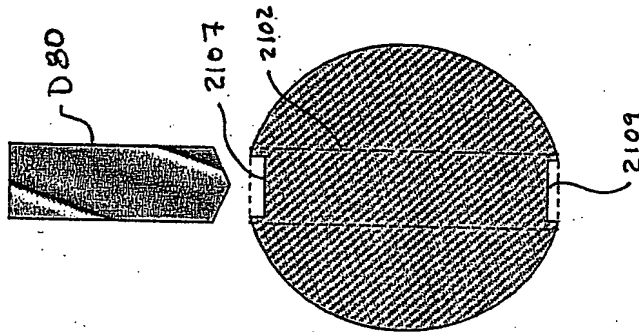


FIG. 81

Final Configurations

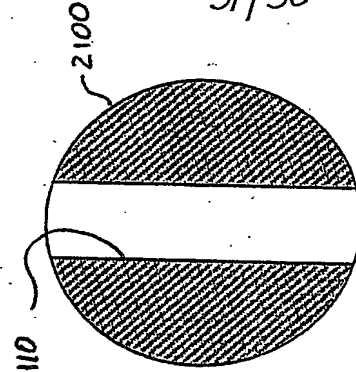
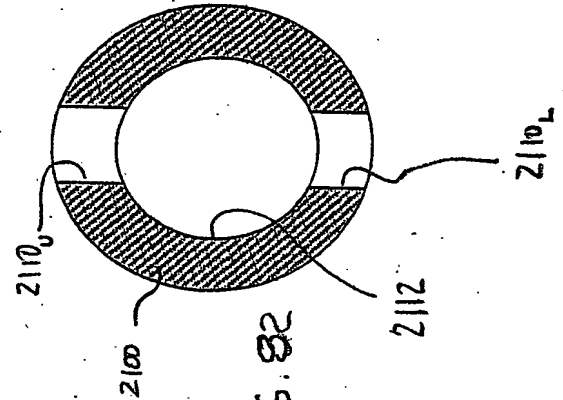


FIG. 82



Treatment of a solid bar

FIG. 83

Setup step

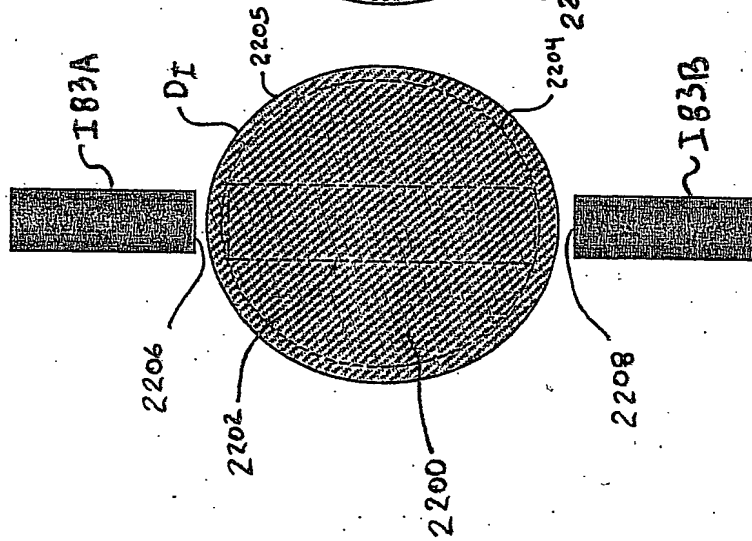


FIG. 84

Processing

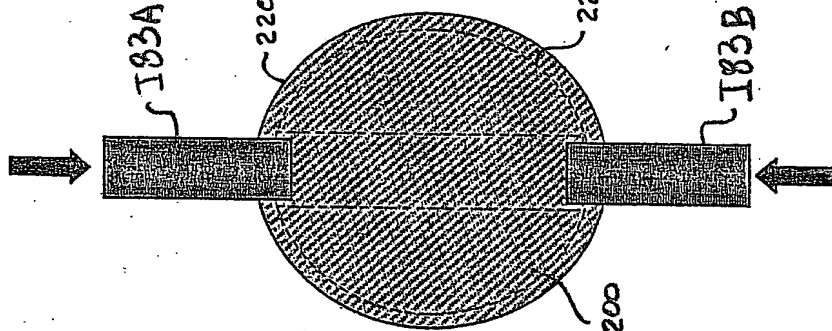


FIG. 85

Drill Hole

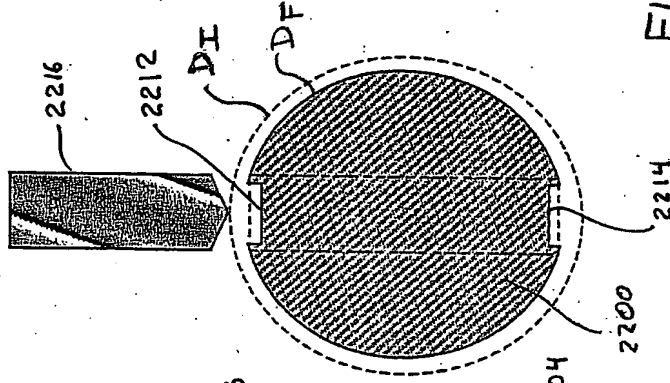


FIG. 86

Final Configurations

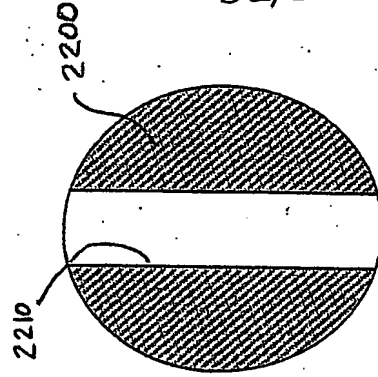
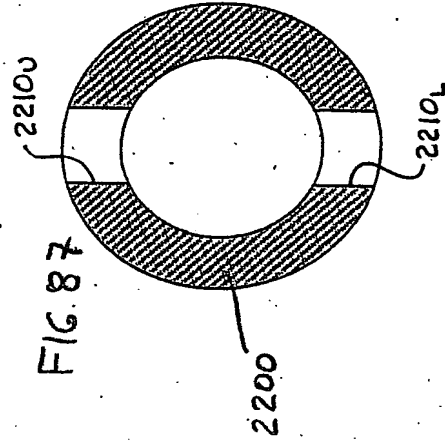


FIG. 87



Treatment of an initially oversized solid bar

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FIG. 88

Setup step

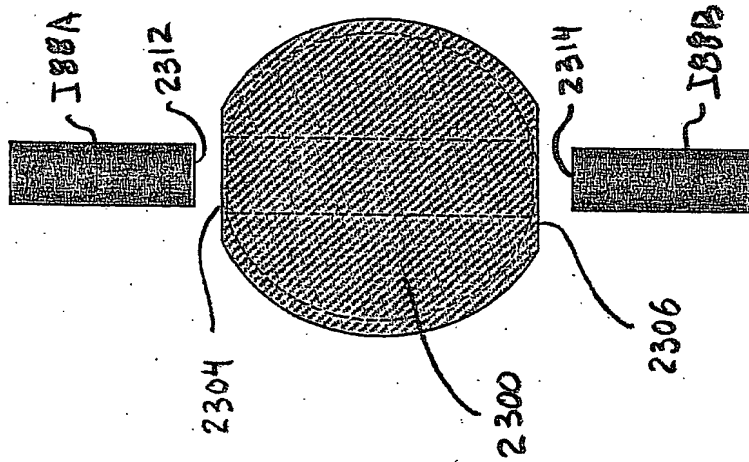


FIG. 89

Processing

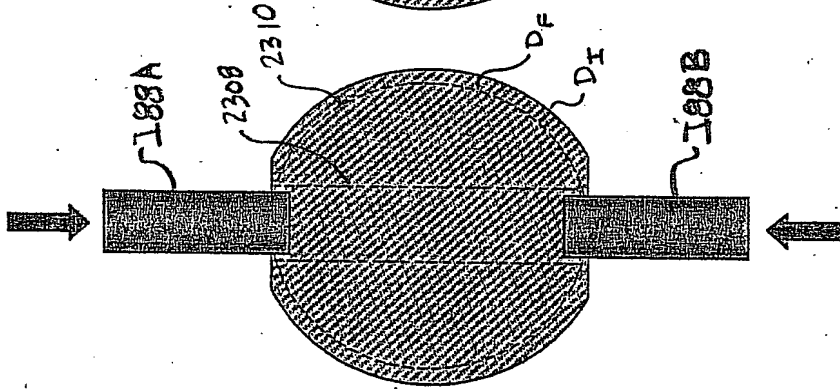


FIG. 90

Drill Hole

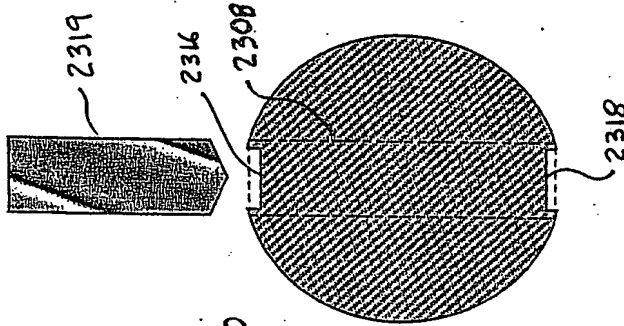


FIG. 91

Final Configurations

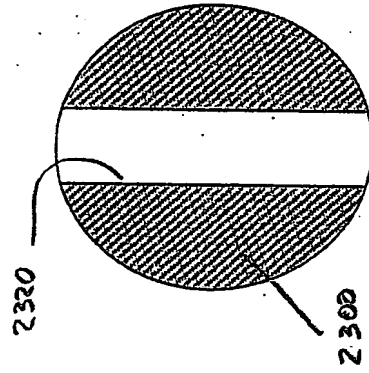
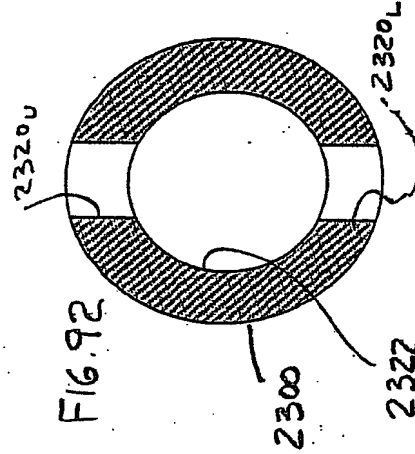


FIG. 92



Treatment of an initially oversized solid bar with opposing "flats" to facilitate treatment

200EFO" 8049900F

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FIG. 93

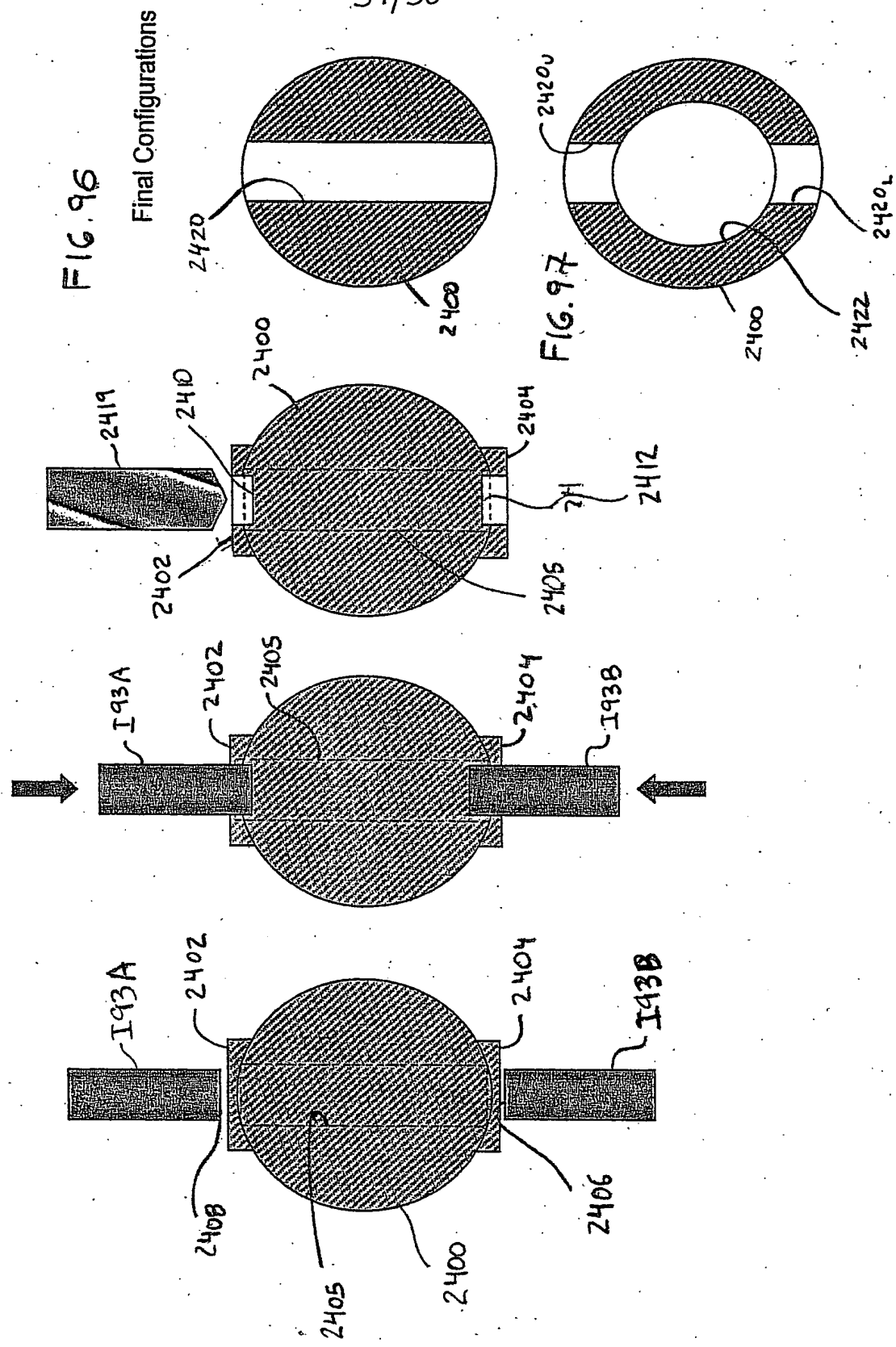
Setup step

FIG. 94

Processing

FIG. 95

Drill Hole



Treatment of a solid bar with milled or integral
"flats" to facilitate the process

20049900T

FIG. 98

Process setup step

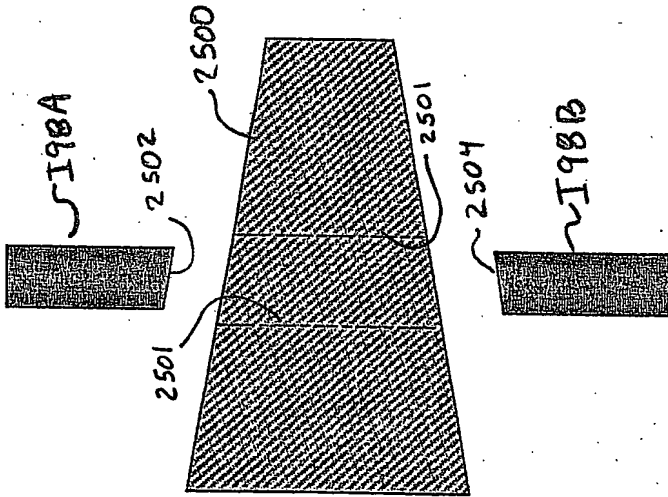
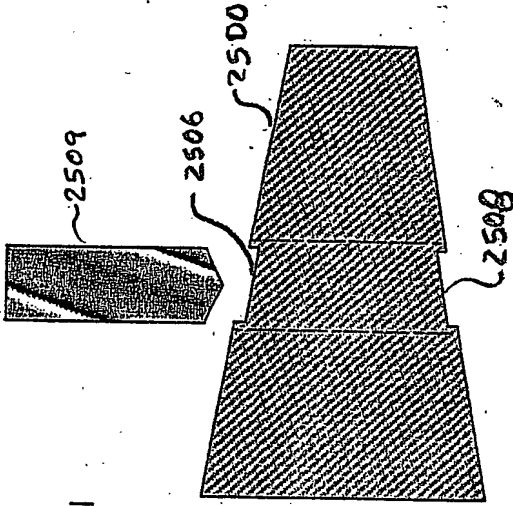


FIG. 99

Drill



Final configuration

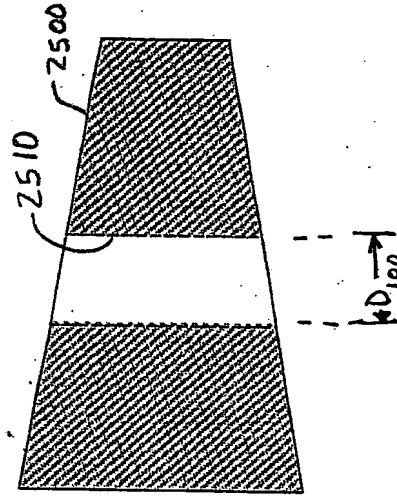


FIG. 100

Treatment of a structure with two tapered surfaces

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FIG. 101

Process setup step

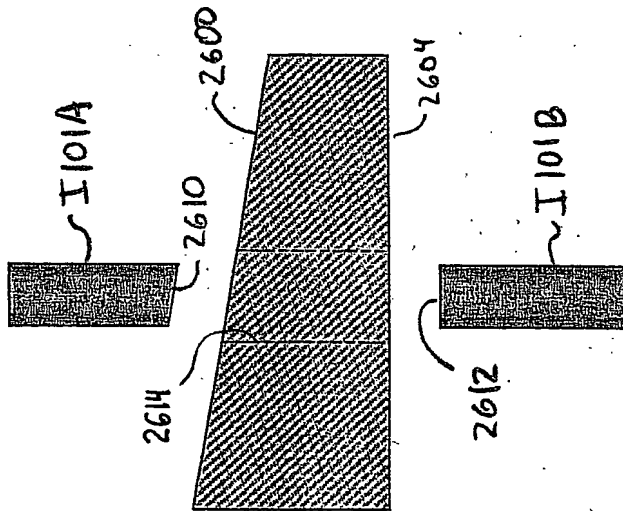
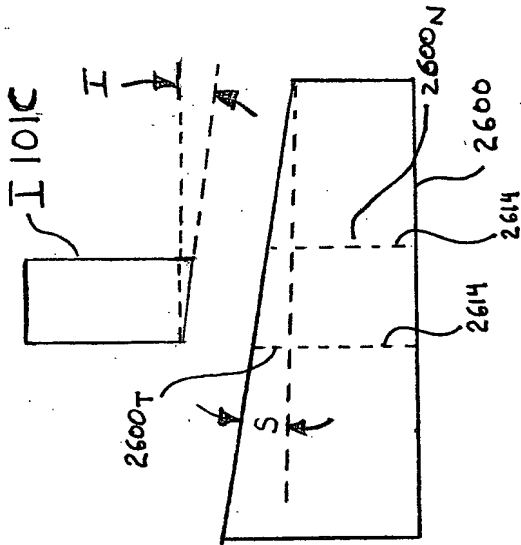


FIG. 101A

FIG. 102



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Final configuration

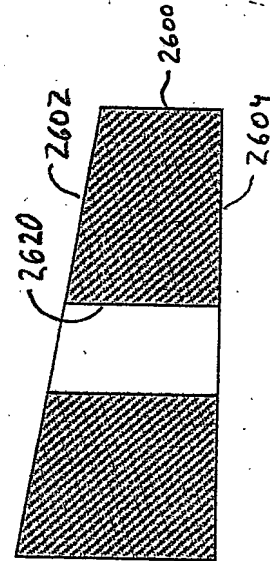


FIG. 103

FIG. 104

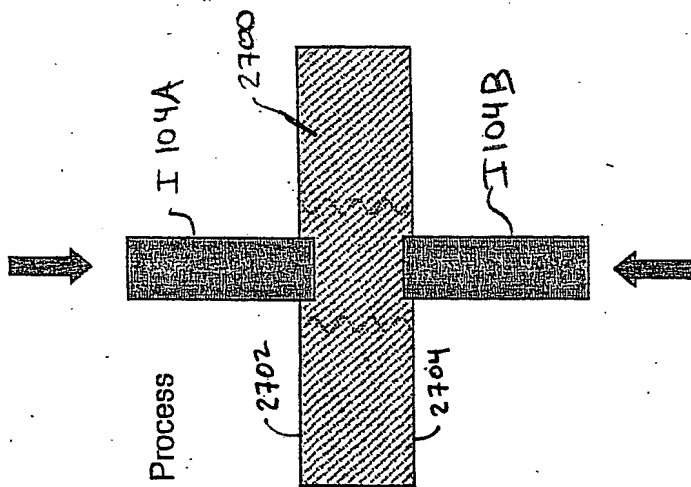


FIG. 105

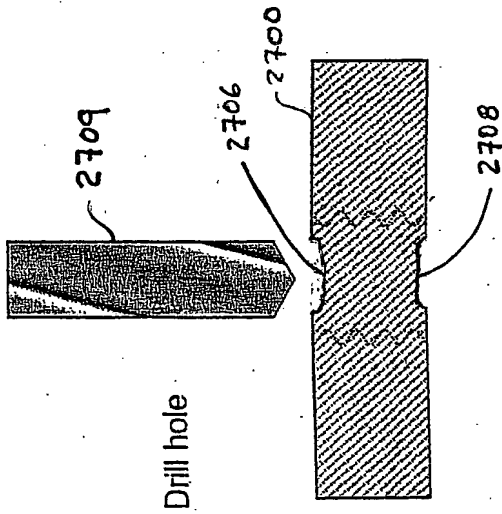
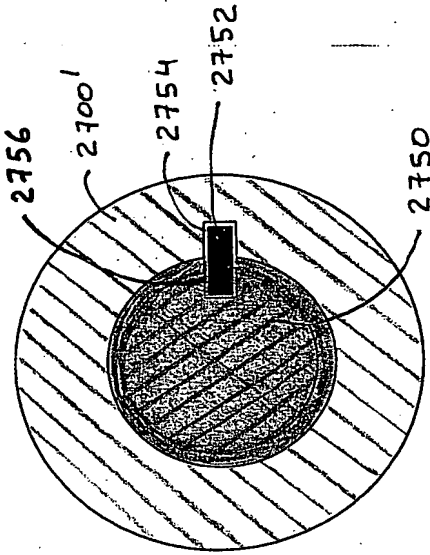


FIG. 106A



Assembled Connection

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FIG. 106

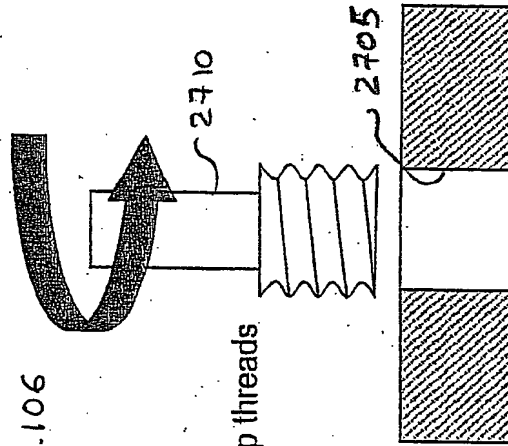


FIG. 106B

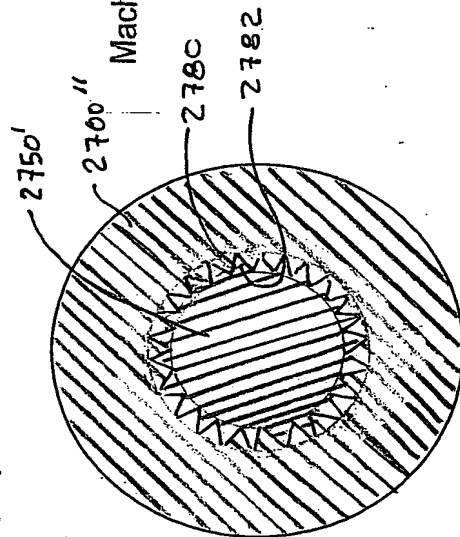
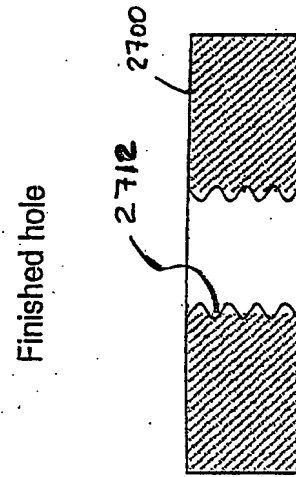
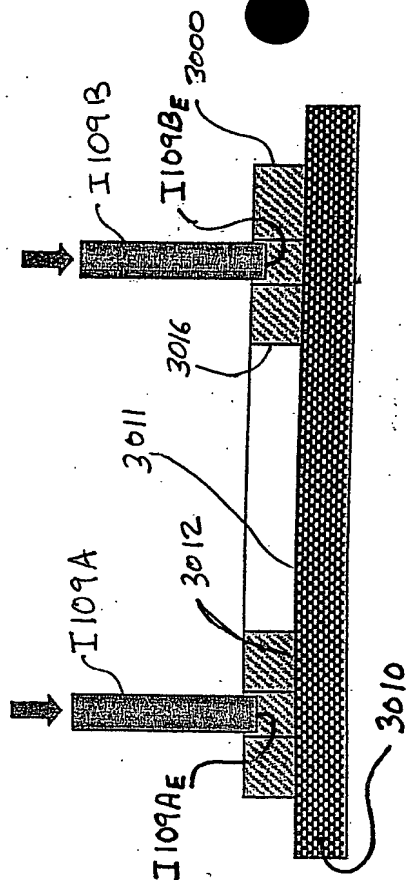
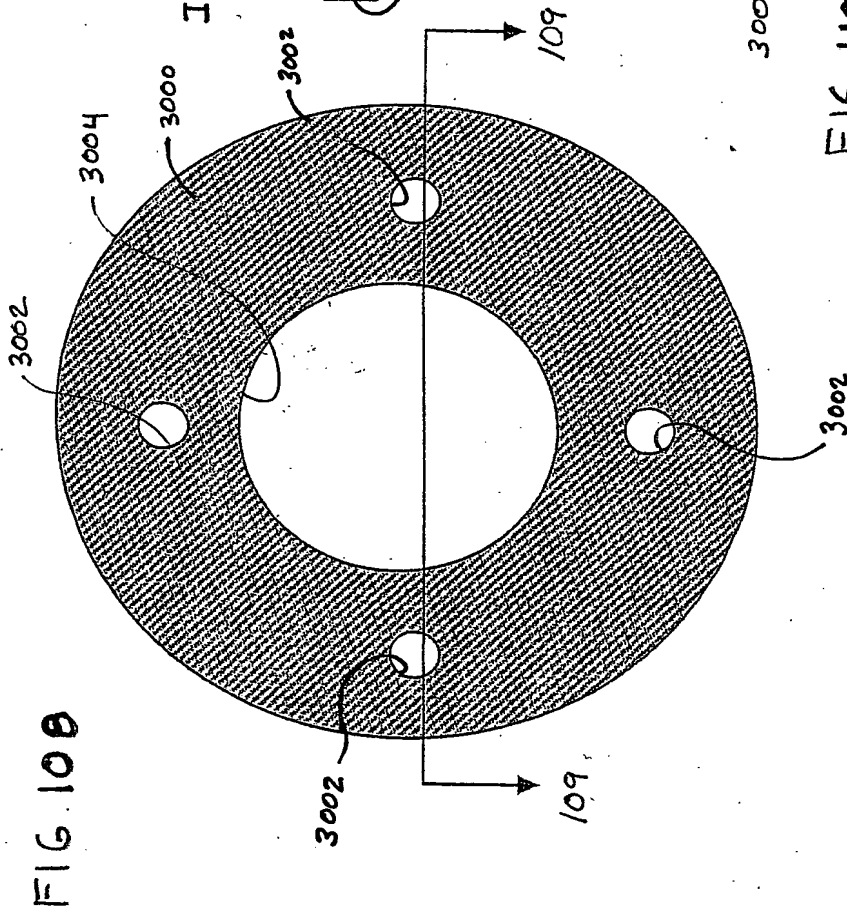
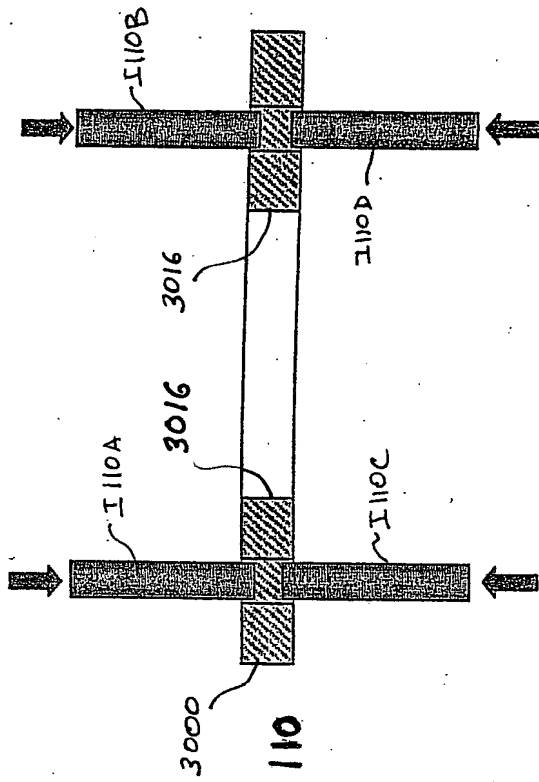


FIG. 107





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Simultaneous or sequential treatment of a pattern
of holes, one-sided or two-sided

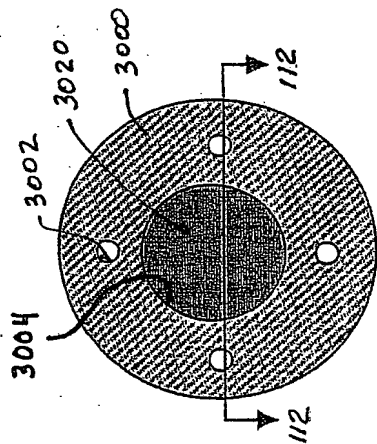


FIG. 111

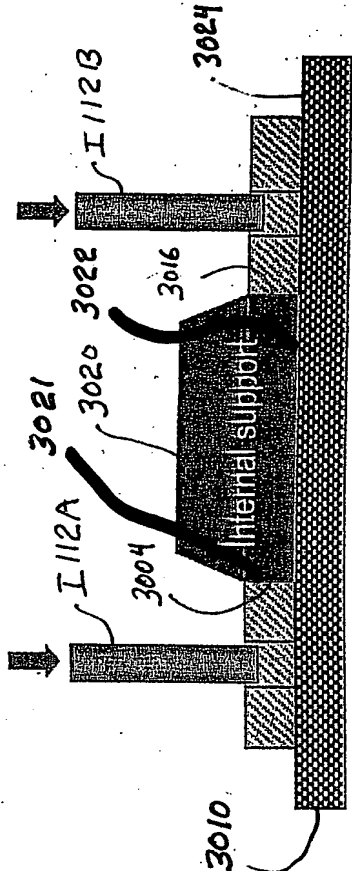


FIG. 114

Support

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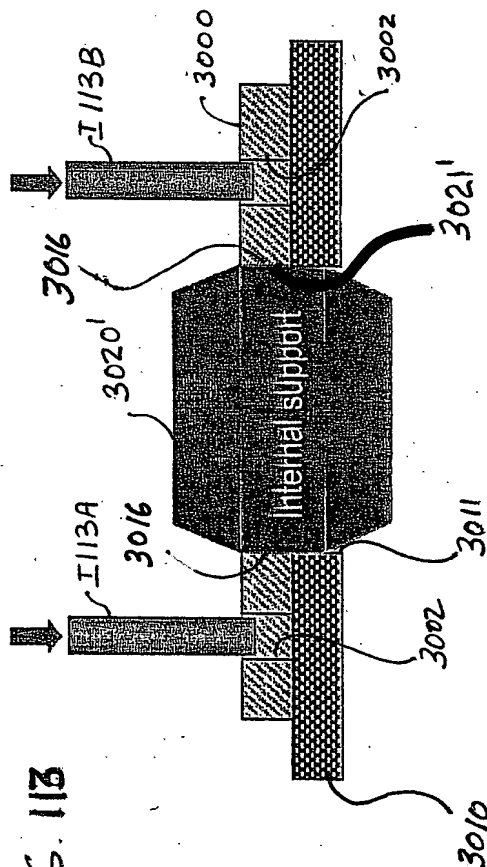
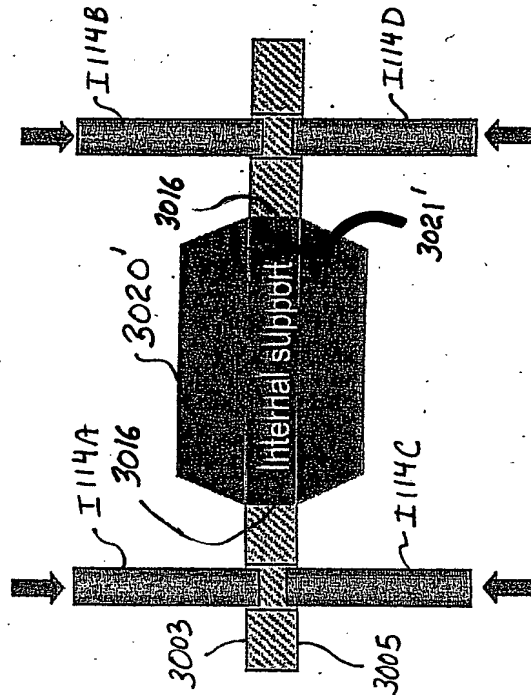


FIG. 113



Simultaneous or sequential treatment of a pattern of holes, one-sided or two-sided with internal support

FIG. 118

Machine large hole diameter

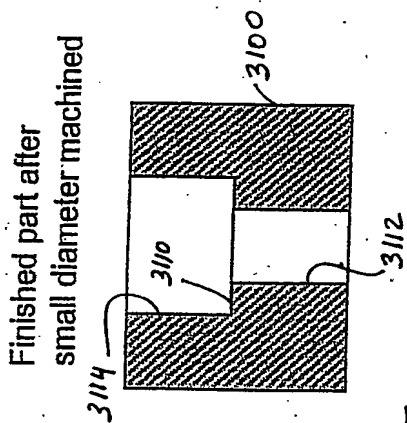


FIG. 115

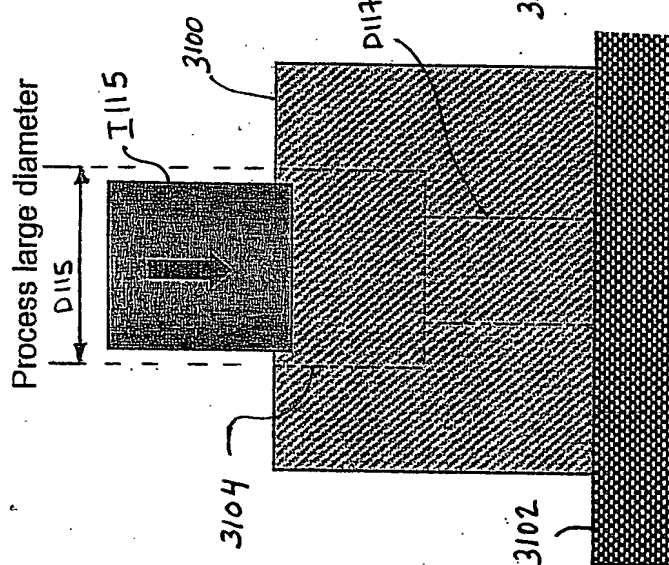
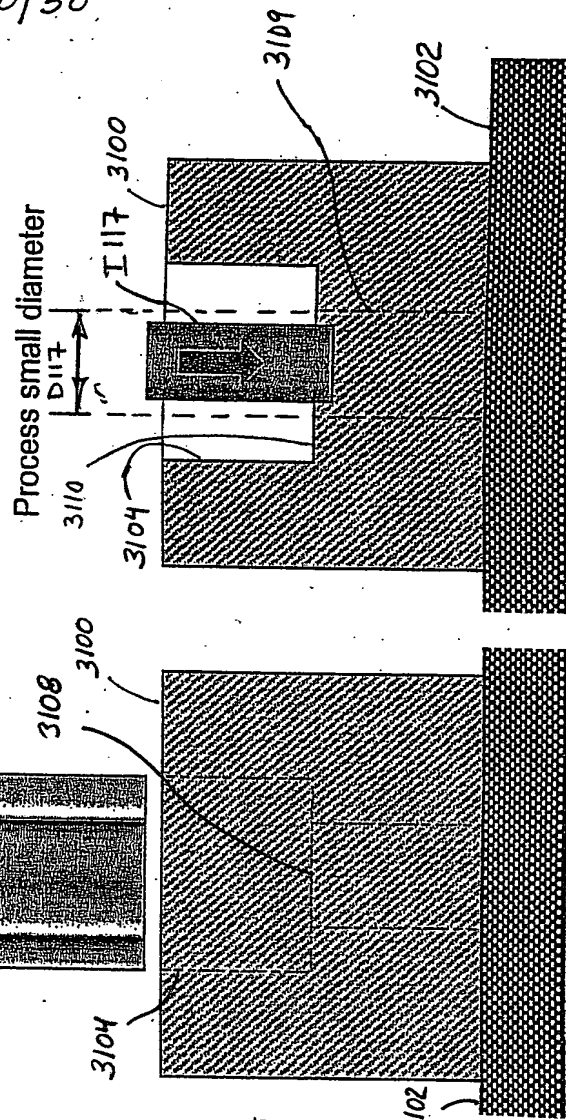


FIG. 117



Treatment of a stepped hole

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FIG. 119

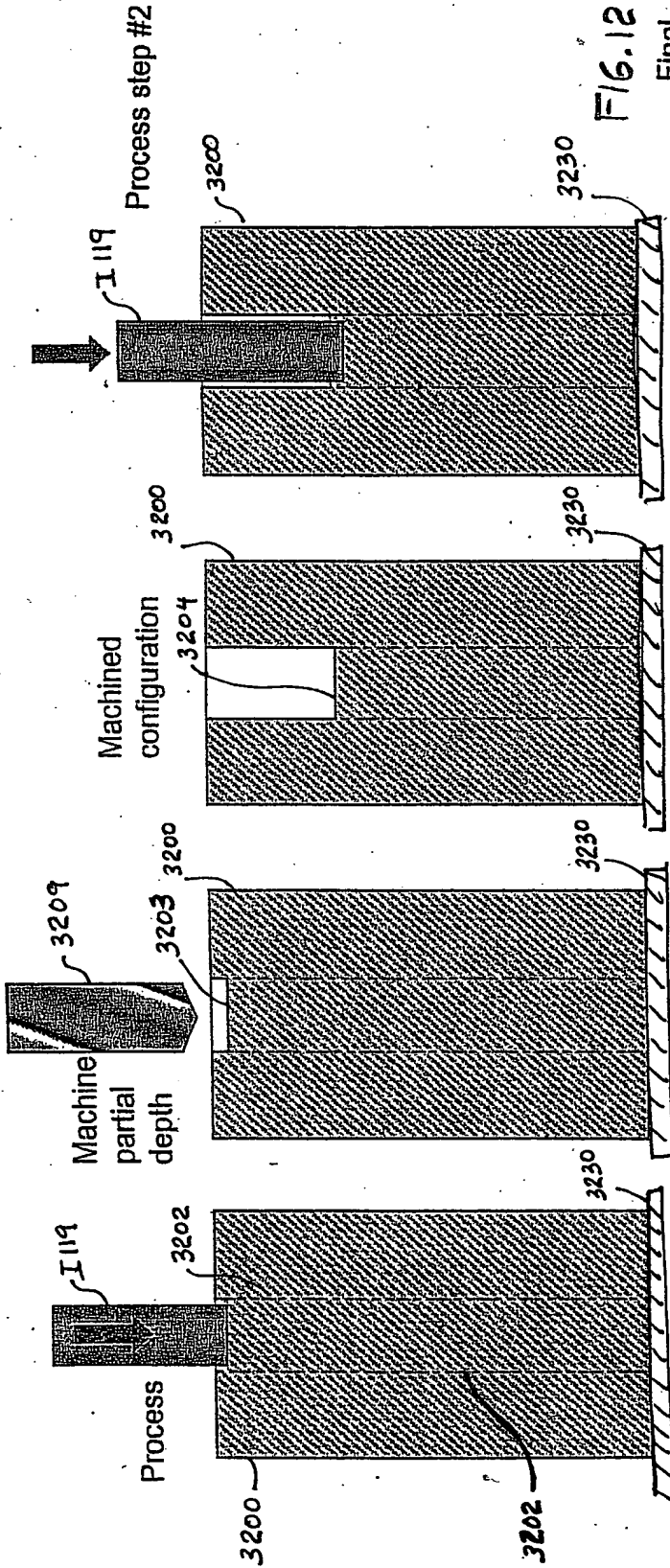
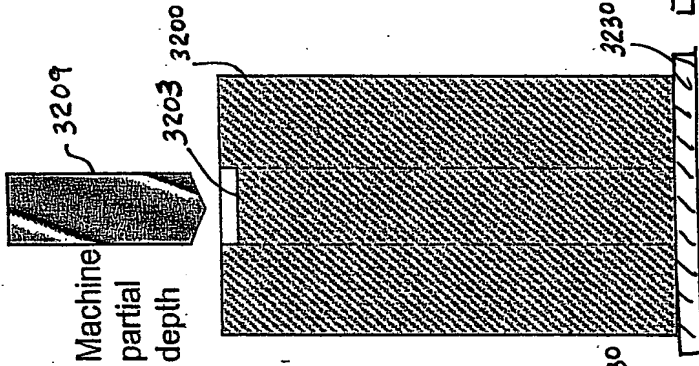


FIG. 120



Machined configuration

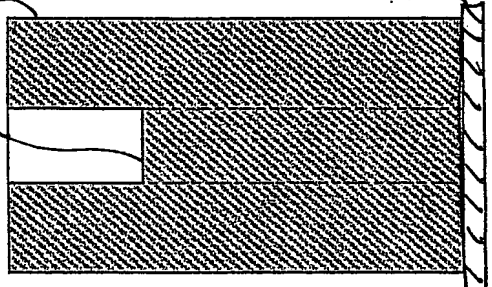
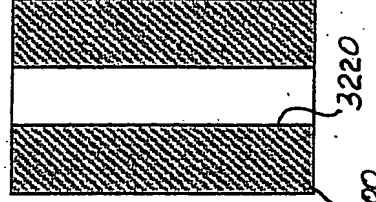


FIG. 127

Final configuration



Treatment of a deep part

FIG. 125

Process step #3

FIG. 125

FIG. 124

FIG. 123

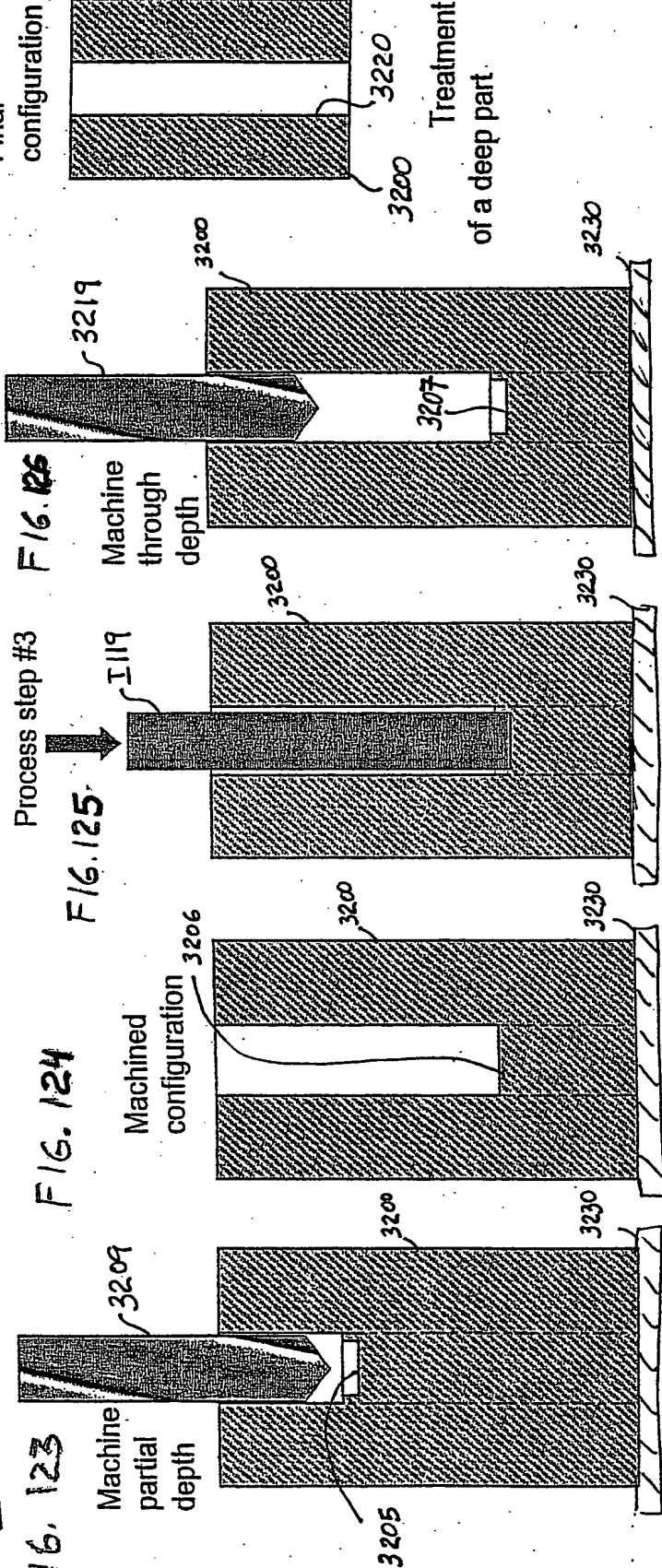


FIG. 120

FIG. 129

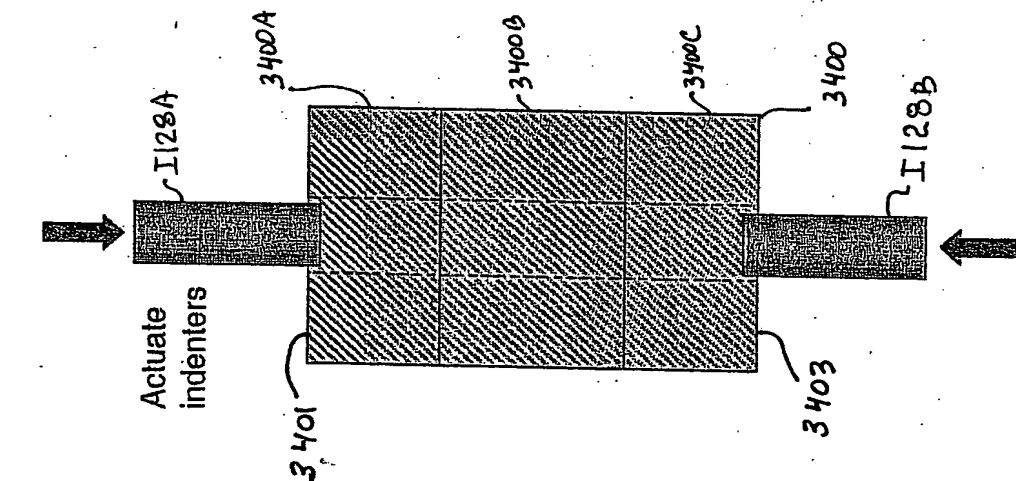
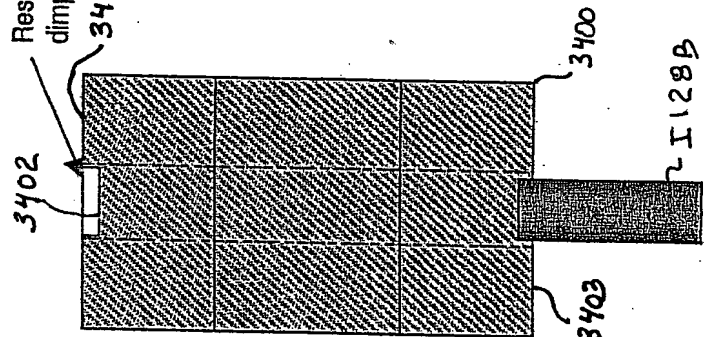


FIG. 129

Remove 1st indenter
 Unload 2nd indenter



Setup step
 For machining
 Partial depth

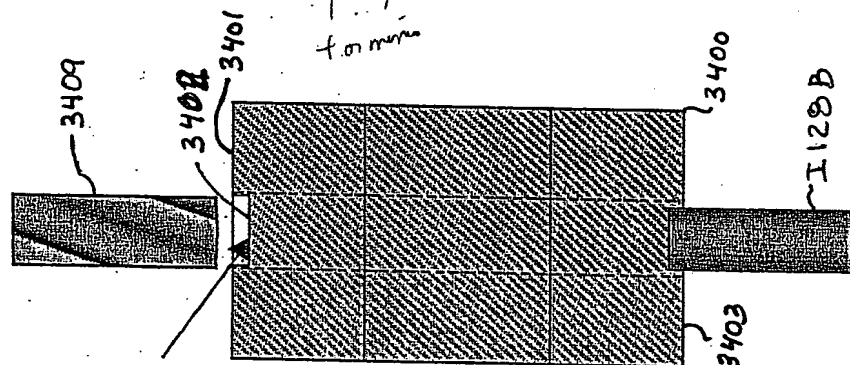
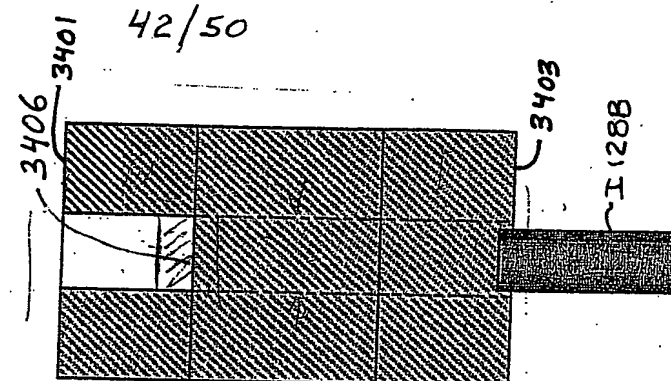


FIG. 131

Interim
 machined
 configuration



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FIG. 132

Process step #2
Actuate indenters

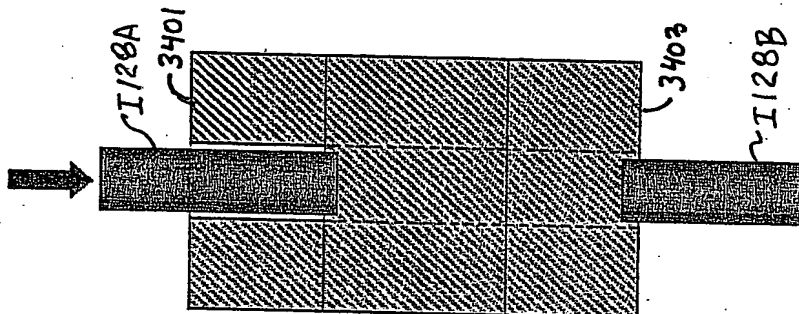


FIG. 133

Release and remove
indenters

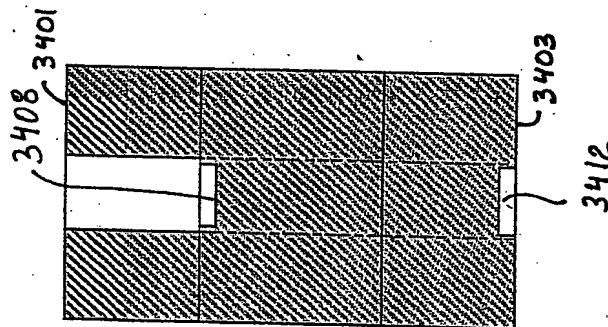


FIG. 134

Final machine
hole

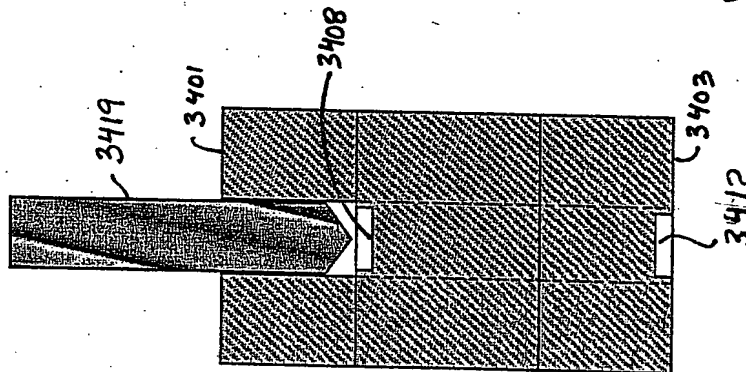
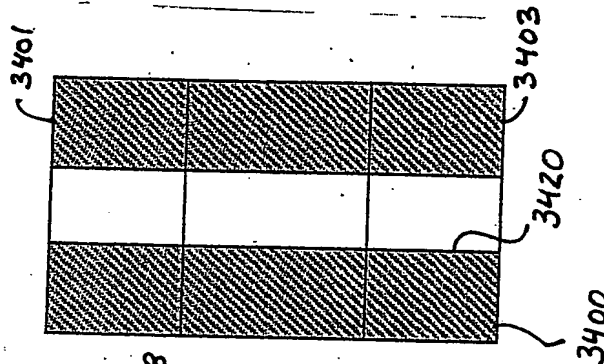


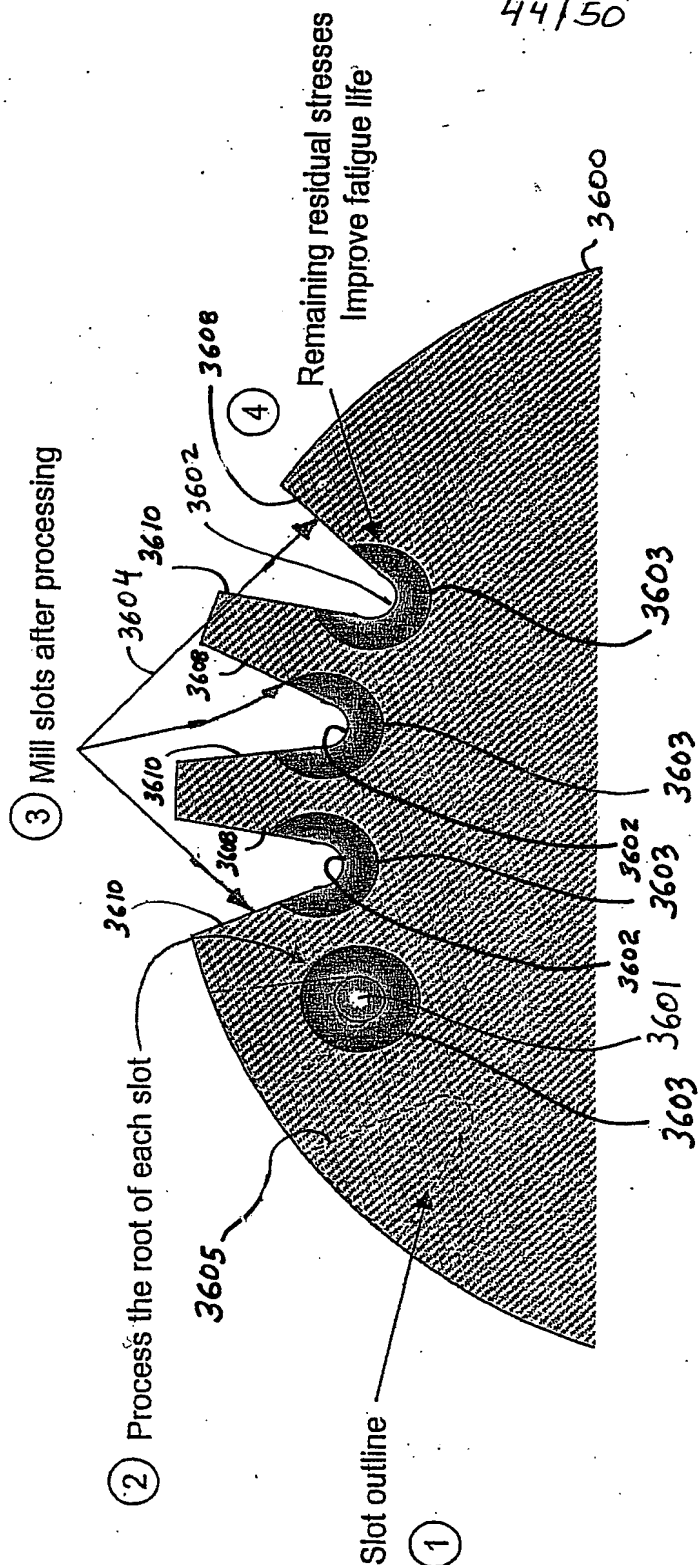
FIG. 135

Final configuration
Note: hole may have
countersink, counter-
bore, step, or other
feature

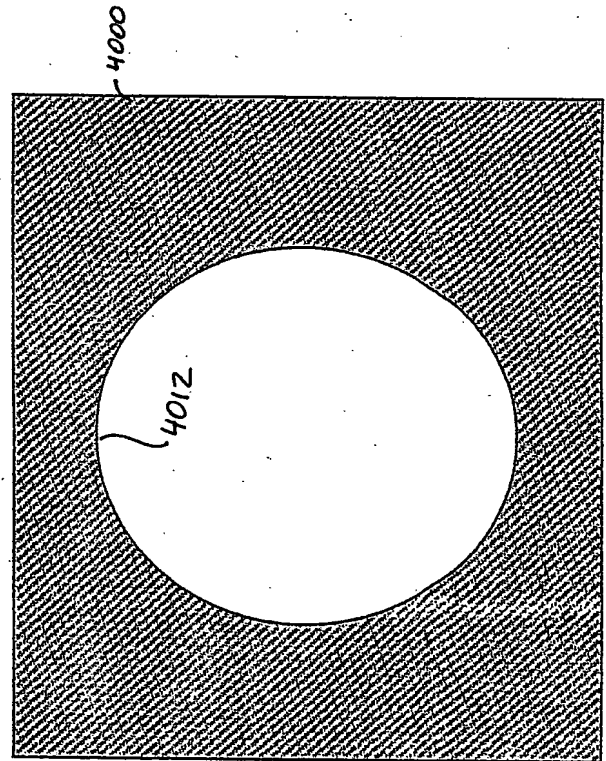
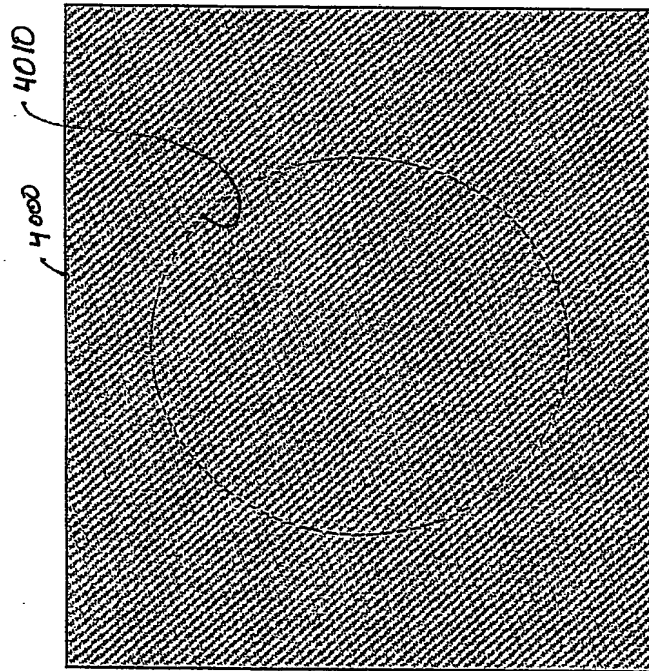
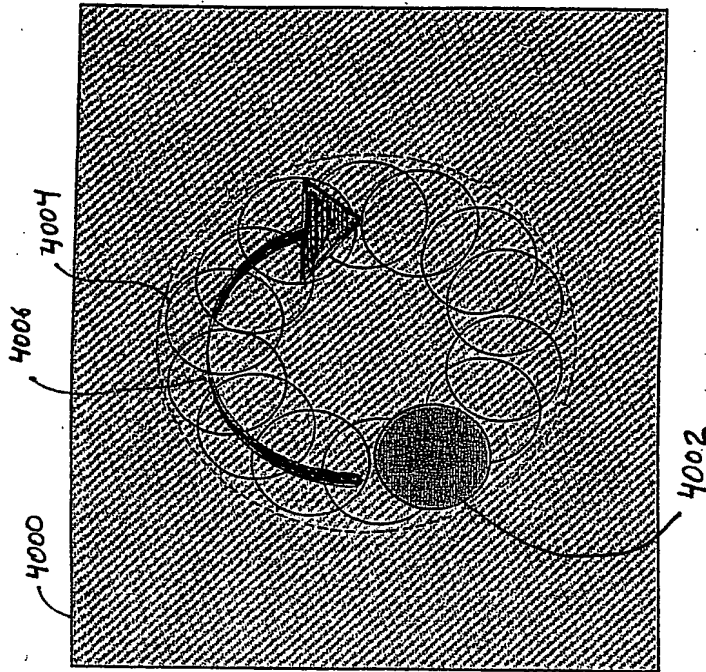


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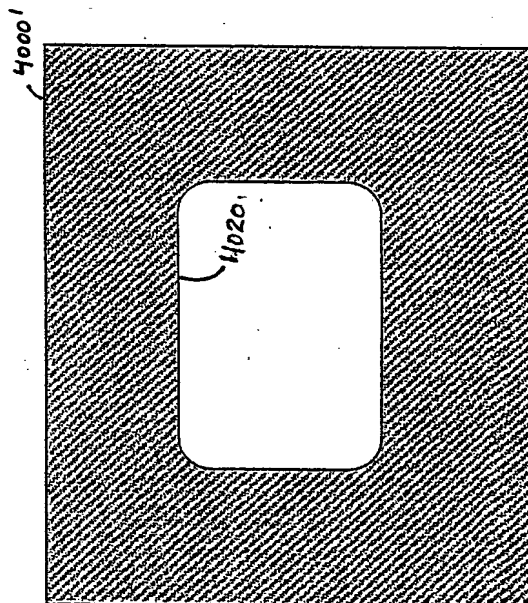
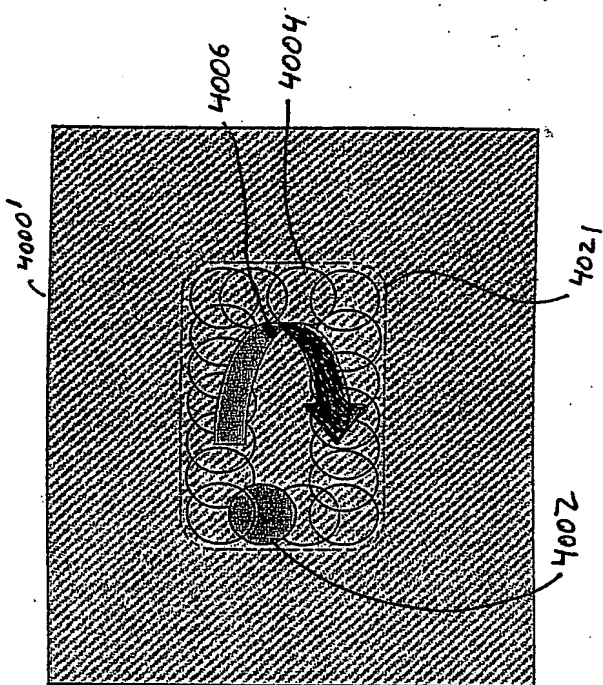
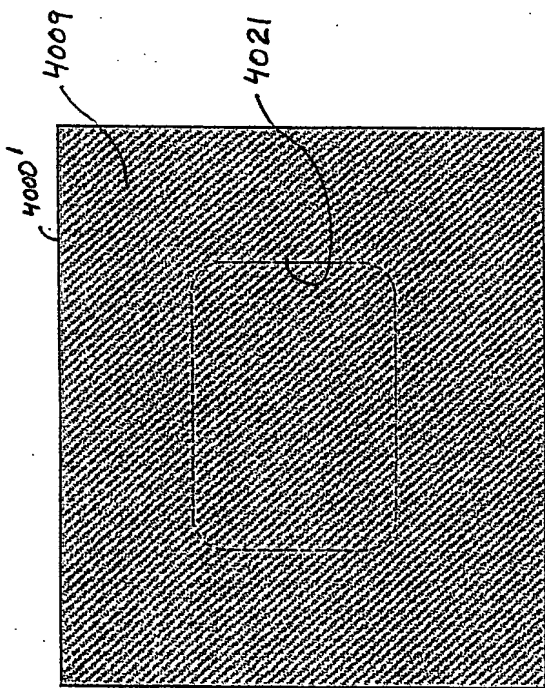
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Treatment of a slotted structure such as a gear or disk

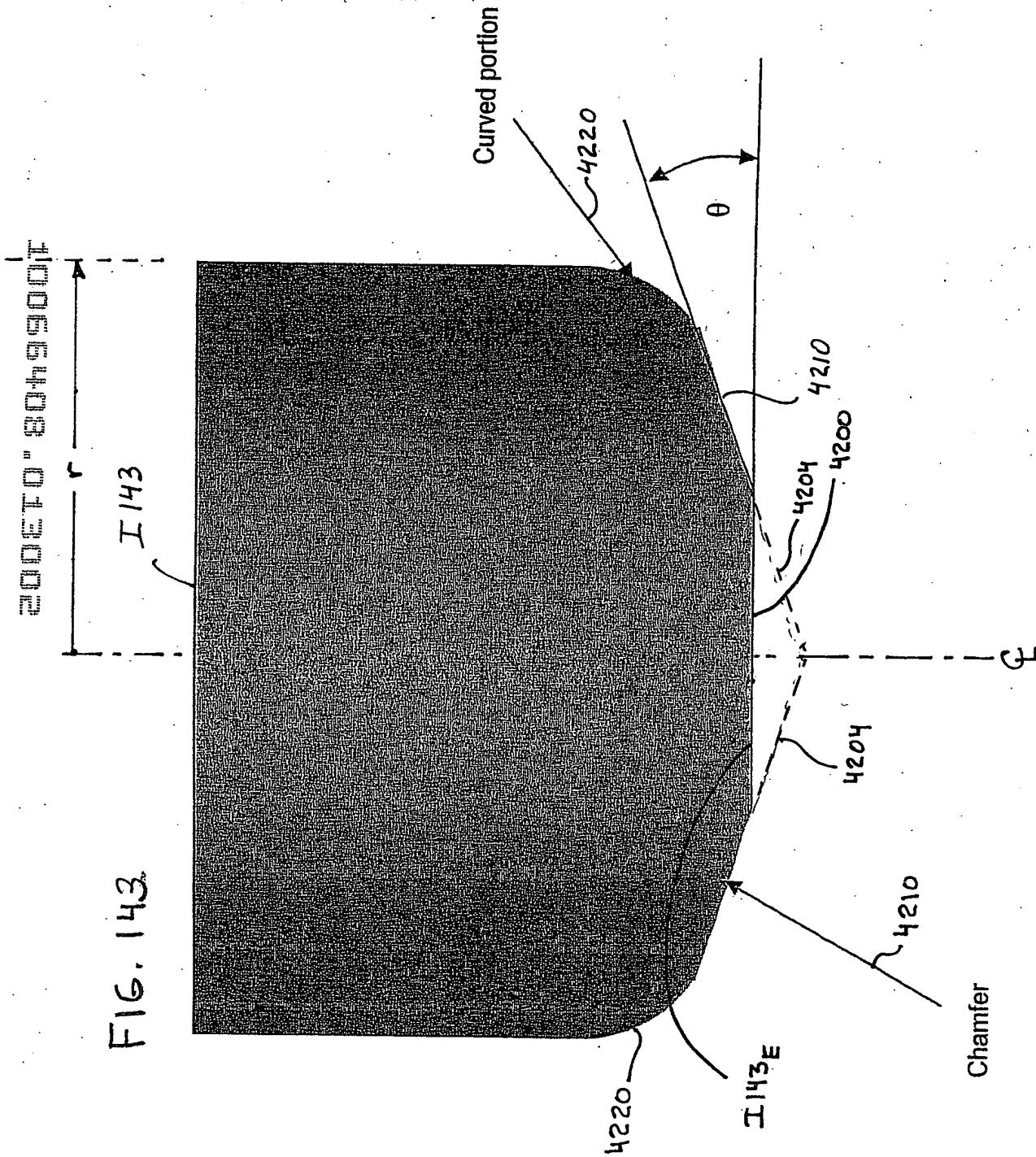


Treatment of a
round aperture using an
overlapping pattern of
dimples around the perimeter



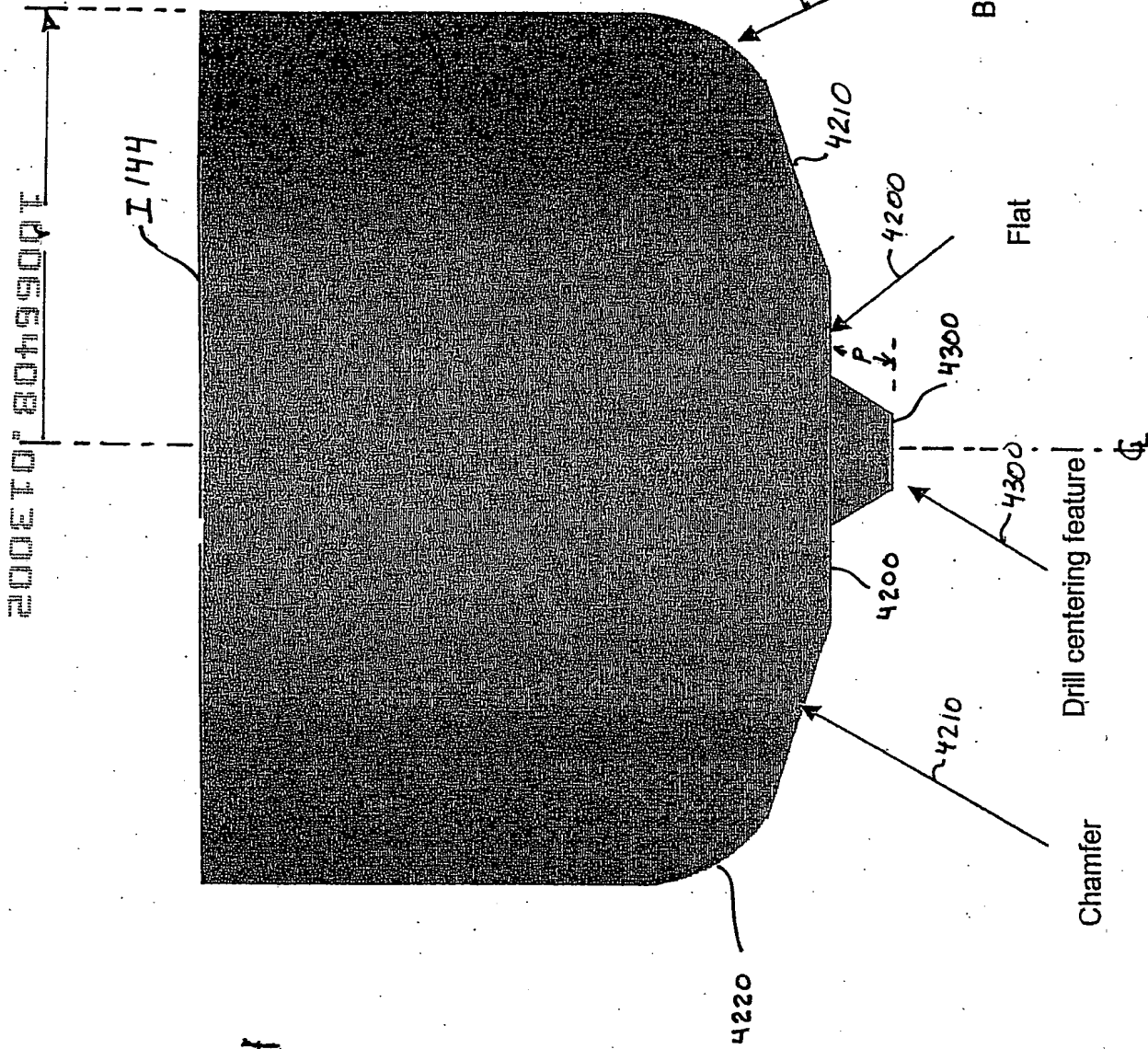
Treatment of a
non-circular aperture using
an overlapping pattern of
dimples around the perimeter

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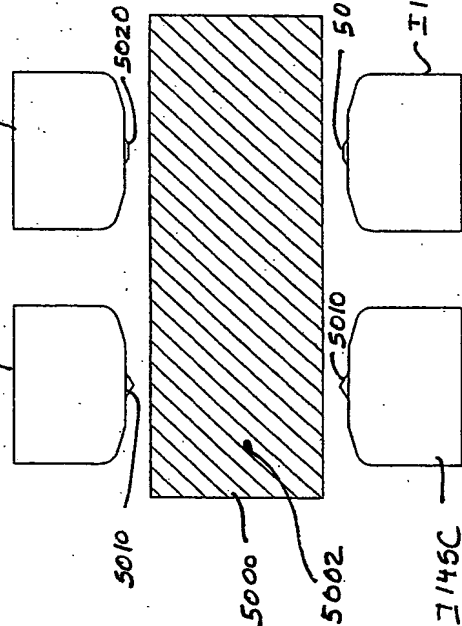
Indenter end shape using flat, chamfered and curved portions for approximating a uniform pressure profile

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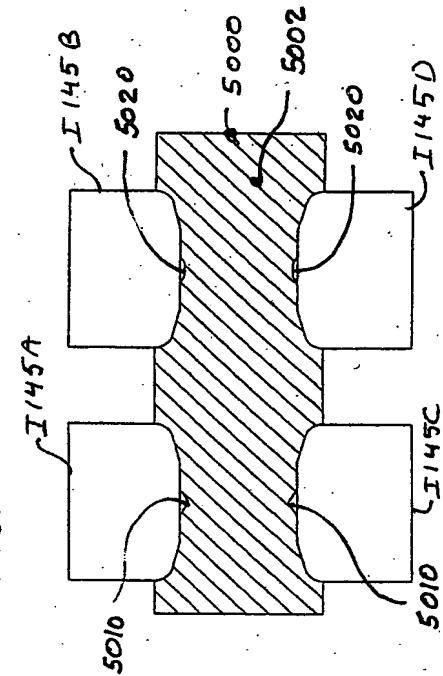
Indenter end shape for approximating a uniform pressure profile with drill center feature

FIG. 145



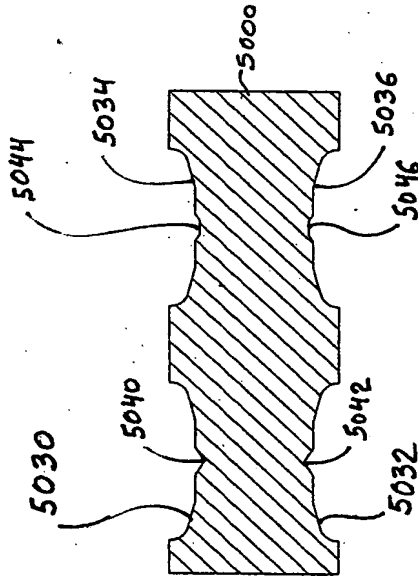
Setup Step for Two Indenter End Styles
With Drill Aligning Feature. One Conical and the
Other a Truncated Cone

FIG. 146



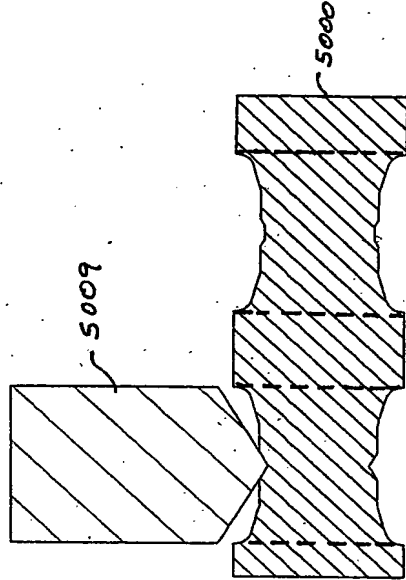
Actuation of Indenters Into Part

FIG. 147



Cross Section of Dimples After
Treatment and Indenter Withdrawal

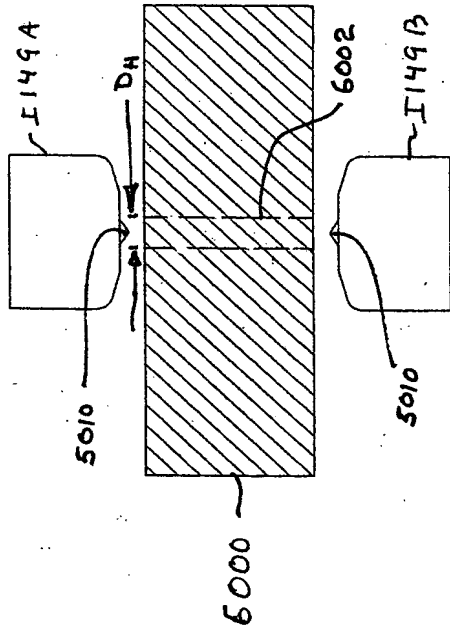
FIG. 148



Drill Out Hole, Drill Centers on Dimple

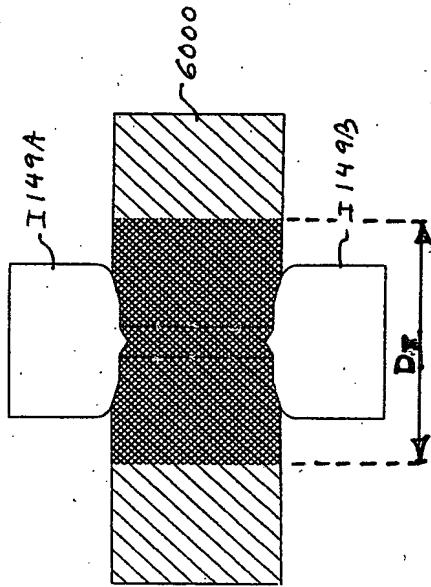
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FIG. 149



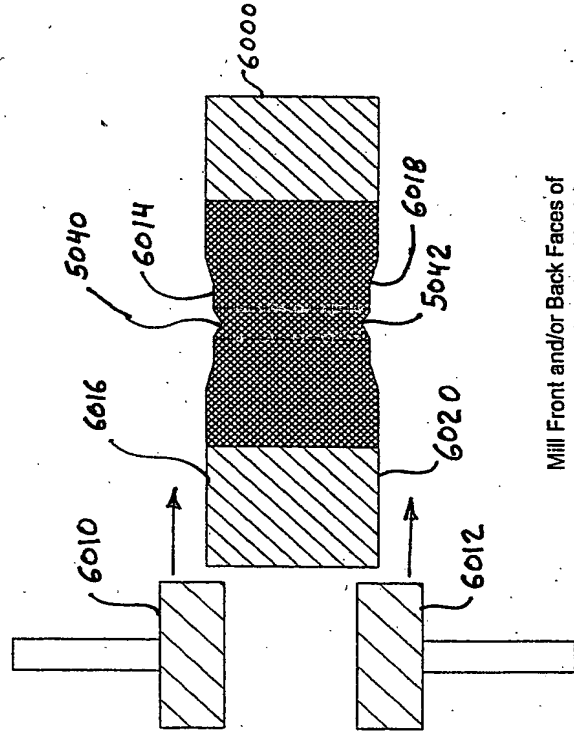
Setup Step for Treating Part With Extra Thickness Using Indenters Much Larger Than the Final Hole Diameter

FIG. 150



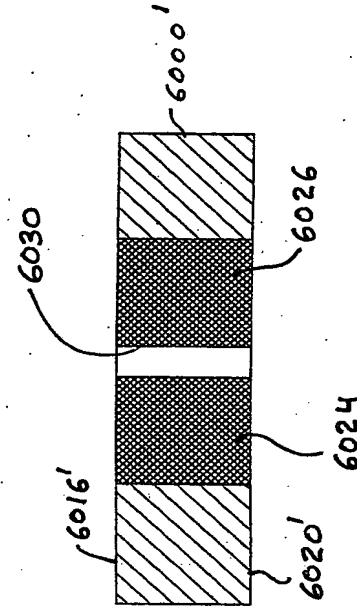
Actuation of indenters into Part, Extent of Residual Stress Well Beyond the Future Wall of the Small Diameter Hole

FIG. 151



Mill Front and/or Back Faces of Structure to Remove Dimples - Residual Stresses May Relax Slightly

FIG. 152



Drill Out Hole Leaving Large Zone of Compressive Residual Stress